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Clinical study

Telemedicine during and post-COVID 19: The insights of neurosurgery patients and physicians



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ABSTRACT

Objective: COVID-19 has caused a massive surge in telemedicine utilization as patients and physicians tried to minimize in-person contact to avoid the spread and impact of the pandemic.

This study aims to expand on the knowledge of telemedicine during and beyond the COVID-19 era as it pertains to its use, efficacy, and patient and provider satisfaction through surveys.

Methods: This is a retrospective study involving 93 patients and 33 Neurosurgery physicians who anonymously participated in the survey about their experience with telemedicine visits.

Results: Most respondents indicated extreme satisfaction with their telemedicine encounters during the pandemic (77%). As for how comfortable physicians are in providing a diagnosis via telemedicine compared to clinic visits, 7 (21.9%) physicians felt extremely comfortable, 13 (40.6%) felt somewhat comfortable, 2 (6.4%) were neutral, 9 (28.1%) felt somewhat uncomfortable and 1 (3.1%) felt extremely uncomfortable. Physical examination was the main tool that telemedicine didn't provide (n = 21, 100%).

Conclusion: Telemedicine has become a major force in the health care system under the circumstances the world is witnessing. Physicians and patients have displayed high levels of satisfaction with telemedicine which could be pivotal to improving healthcare access to underprivileged areas beyond the pandemic.

1. Introduction:

The COVID-19 pandemic was officially announced on March 11, 2020, by the World Health Organization [1]. The COVID-19 pandemic has had a profound impact on clinics and other healthcare institutions. One of the major changes was the massive increase in telemedicine utilization as patients and physicians tried to minimize in-person contact to avoid the spread of the disease [2,3]. Although telemedicine was in use before the pandemic, its use exponentially increased in the early months of the pandemic. In February of 2020, the Center for Disease

Control and Prevention issued guidelines encouraging health care providers to use social distancing and offer services through telehealth [4]. In general, telemedicine increases access to care while minimizing viral exposure to both patients and providers. However, the use of telemedicine also brings several challenges to patients and physicians. Herein, we seek to expand on the knowledge of telemedicine during and after the COVID-19 era as it pertains to its use, efficacy, and patient and provider satisfaction through surveys. This study reports on the survey conducted to understand the telemedicine experience amongst patients and physicians.

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2. Methods

The study protocol was reviewed and approved by the Institutional Review Board (IRB). Also, the study was exempted from IRB review because patients were anonymized, and the study poses minimal risk to the privacy of the participants. Literature was reviewed to obtain common concerns about telemedicine. Based on this, a survey with 22 questions was sent to patients and a 17-question survey for physicians. The surveys were created using Qualtrics and consisted of a mixture of multiple choice and rank-order questions.

The surveys were sent to physicians and patients who experienced a telemedical encounter in the Neurosurgery department between April 2020 and April 2021. Patients from the first and last telemedical encounter of each physician was chosen for the study to eliminate any form of selection bias. We obtained 410 patients but only 93 consented to participate. Phone numbers were obtained from the medical charts, and patient were called, provided with all the project information and endpoints, assured that their answers were anonymous, and asked for consent before asking them the survey questions. As for the physicians, they were sent a survey link along with the IRB- approved recruitment statement.

3. Results

Overall, in this retrospective study, 93 patients and 33 Neurosurgery physicians anonymously participated in the survey regarding their experience with telemedicine visits.

3.1. Patient Survey

3.1.1. Telemedicine convenience, ease-of-use, and satisfaction

When asked about ease of communication via telemedicine, a majority of patients responded that it was “very easy” (n = 65, 71.4%). Most respondents found that their healthcare provider understood their concerns (n = 86, 96.6%). With respect to clarity, 74 (81.3%) respondents were able to hear their healthcare provider “very clearly”. Moreover, when asked about the amount of information understood, 72 (82.8%) respondents were able to understand “a great deal” of their physician’s instructions and 10 (11.5%) understood “a lot”. As for ease of use, 67 (74.4%) respondents found it “very easy” to use telemedicine, 86 (95.6%) respondents had the technology required for their telemedicine encounter and 65 (71.4%) patients didn’t face any problem while using telemedicine.

When asked about their satisfaction with their telemedicine encounters, most respondents were extremely satisfied (n = 67, 77%). (Fig. 1a) It was important to assess the willingness to participate in more telemedicine encounter, and most respondents agreed (n = 49,57%). However, only a minority of respondents were using telemedicine more frequently than clinic visits to meet their health care provider (n = 31, 36%).

3.1.2. Impact of telemedicine on care delivery

All the patients indicated that they had never taken wrong medications due to a miscommunication via telemedicine and stated that they had never had their diagnosis or management changed after a telemedicine session (n = 87, 100%).



Fig. 1. a. Overall satisfaction of patients with their telemedical encounters; b. Ease of communication with health care provider; c. Satisfaction of patients with telemedicine compared to clinic visits; d. Thoughts on telemedicine in the post-COVID 19 era.

3.1.3. Advantages and disadvantages of telemedicine

With respect to advantages of telemedicine, respondents were asked to rank the given advantages from most important to least important. According to the patients, the most important advantage of telemedicine was its superior convenience compared to clinic visits (n = 49, 57.7%) followed by cost effectiveness (n = 28, 32.9%), protection against infectious diseases (n = 27, 31.8%) and lastly less waiting time (n = 41, 48.2%).

Respondents were also asked to rank four potential disadvantages of telemedicine. Here, there were less responses, as many respondents felt as if none of the options were applicable to their experience. Nearly half (46.7%; n = 21) of respondents felt that technological difficulty was the most relevant disadvantage of telemedicine; whilst 31.1% (n = 14) found that less privacy in telemedicine was the second most important disadvantage and 33.3% (n = 15) felt that telemedicine requiring expensive technology they could not afford was the third most important disadvantage. Moreover, 46.7% (n = 21) reported difficulty in conveying their concerns was the fourth most important out of the possibilities given.

3.1.4. Comparison between telemedicine and clinic visits

With respect to privacy, 84.3% (n = 75) respondents found that telemedicine had the “same level” of privacy compared to a clinic visit, while 13.4% (n = 12) found it to be “more private” and 2.3% (n = 2) found it “less private”. As for waiting time and delay, 40 (45.5%) respondents felt that they experienced a “similar amount” of delay using telemedicine, 38 (43.2%) felt that there was “less delay”, and 10 (11.3%) experienced “more delay” than a clinic visit. Regarding trust in the physician’s judgement, 80 (94.1%) respondents reported “same level of trust” in their physician’s diagnosis via telemedicine compared to a clinic visit, with only 1 (1.2%) having “less trust”. Moreover, 62 (71.3%) respondents reported to have spent a “similar amount of time” with their healthcare provider via telemedicine, while 21 (24.1%) spent “less time” and 4 (4.6%) spent “more time”. In addition, 36% (n = 31) respondents said they were meeting with their healthcare provider more frequently via telemedicine than in person. Compared to clinic visits, 56 (62.2%) respondents found it “extremely easy” to deliver their concern, 20 (22.2%) found it “somewhat easy”, and 8 (8.9%) found it somewhat difficult. (Fig. 1b) When asked about their satisfaction with telemedicine compared to clinic visits, most patients were extremely satisfied (n = 64, 73.6%). (Fig. 1c).

3.1.5. Future of telemedicine in the Post-Covid era

When presented with the statement that telemedicine should remain as an option for medical appointments in the post-Covid era, most respondents strongly agreed (n = 71, 81.6%) and the majority strongly agreed that they will be doing more telemedical encounters (n = 49, 57%). (Fig. 1d) As for the option of telemedicine replacing clinic visits, 16 (18.4%) respondents said they strongly agree with the proposition, 17 (19.5%) said they agree, 13 (14.9%) said they were neutral, 22 (25.4%) said they disagree, and 19 (21.8%) said they strongly disagree. Answers are summarized in Table 1.

3.2. Physician Survey

3.2.1. Overview

When asked about the level of skepticism towards telemedicine, most physicians were somewhat in the less skeptical side. Moreover, most physicians are using both telemedicine and clinics to meet with their patients (n = 29, 87.9%) and the majority are facing more difficulties when seeing a new patient (n = 28, 87.5%) rather than a follow-up (n = 4, 12.5%). Also, most physicians were having problems in the technical aspect of the telemedical call (n = 26, 81.3%) however, most physicians were forced to substitute to a phone call for technical reason in only about 0–25% of their telemedical encounters (n = 19, 59.4%) (Fig. 2a).

Table 1
Summary of the patient survey results.

Question	N (%)
Telemedicine convenience, Ease-of-use, and Satisfaction	
1. On a scale of 1-5, 1 being very easy and 5 being very difficult, how easily could you communicate with your health-care provider through telemedicine?	
1	65 (71.4)
2	8 (8.8)
3	9 (9.9)
4	8 (8.8)
5	1 (1.1)
2. In general, did you feel that your health-care provider understood your concern?	
Yes	86 (96.6)
No	3 (3.4)
3. On a scale of 1 to 5, 1 being very clear and 5 being not clear at all, how clearly could you hear your health-care provider?	
1	74 (81.3)
2	5 (5.5)
3	5 (5.5)
4	5 (5.5)
5	2 (2.2)
4. After your telemedicine session, how much you understood the physician’s instructions?	
A Great Deal	72 (82.8)
A lot	10 (11.5)
A Moderate Amount	5 (5.6)
A Little	0 (0)
None	0 (0)
5. On a scale of 1 to 5, 1 being very easy and 5 being very difficult, how hard was it for you to use telemedicine?	
1	67 (74.4)
2	10 (11.1)
3	8 (9)
4	3 (3.3)
5	2 (2.2)
6. Did you have the technology required for your tele-medical encounter?	
Yes	86 (95.6)
No	4 (4.4)
7. In general, did you have any problem while using telemedicine for the encounter?	
Yes	26 (28.6)
No	65 (71.4)
8. Overall, on a scale of 1 to 5, 1 being very satisfied and 5 being not satisfied at all, how satisfied were you with your telemedicine experience?	
1	67 (77)
2	10 (11.5)
3	4 (4.6)
4	6 (6.9)
5	0 (0)
9. Do you believe that you will be doing more telemedicine encounters?	
Strongly Agree	49 (57)
Agree	17 (19.8)

(continued on next page)

Table 1 (continued)

Question	N (%)
Neutral	11 (12.8)
Disagree	5 (5.8)
Strongly Disagree	4 (4.6)
10. Are you meeting with your health-care provider on telemedicine more frequently via telemedicine than in person?	
Yes	31 (36)
No	55 (64)
Impact of telemedicine on care delivery	
11. How many times did you find yourself taking wrong medications because of miscommunication via telemedicine?	
Once	0 (0)
More than Once	0 (0)
Never	87 (100)
12. How many times did you receive a call after your telemedicine session in which the physician changed your diagnosis and management?	
Once	0 (0)
More than Once	0 (0)
Never	87 (100)
Advantages and Disadvantages of Telemedicine	
13. Can you place the following pros of telemedicine from most important to least important?	
1. More Convenient	49 (57.7)
2. Cost Effective	28 (32.9)
3. Less Risk of Contracting Infectious diseases	27 (31.8)
4. Less waiting times	41 (48.2)
14. Can you place the following cons of telemedicine from most important to least important?	
1. Technological Difficulty	21 (46.7)
2. Less Privacy	14 (31.1)
3. Require expensive technology	15 (33.3)
4. Difficulty in conveying concerns	21 (46.7)
Comparison Between Telemedicine and Clinic Visits	
15. Compared to the clinic visit, how do you rate your sense of privacy via telemedicine?	
Less Private	2 (2.3)
Same level of Privacy	75 (84.3)
More Private	12 (13.4)
16. Compared to your clinic visit, how much delay did you have before reach your turn via telemedicine?	
Less Delay	38 (43.2)
Same	40 (45.5)
More Delay	10 (11.3)
17. Compared to your clinic visit, how much trust do you have in your physician's diagnosis via telemedicine?	
Less Trust	1 (1.2)
Same Level of Trust	80 (94.1)
More Trust	4 (4.7)
18. Compared to your clinic visit, how much time did you spend with your healthcare provider via telemedicine?	
Less Time	21 (24.1)

Table 1 (continued)

Question	N (%)
Same amount of time	62 (71.3)
More Time	4 (4.6)
19. Compared to the clinic visit, how hard was it to deliver your concern to your health-care provider via telemedicine?	
Extremely Easy	56 (62.2)
Somewhat Easy	20 (22.2)
Neutral	6 (6.7)
Somewhat Difficult	8 (8.9)
Extremely Difficult	0 (0)
20. Compared to your clinic visit, how satisfied were you with your telemedicine encounter?	
Extremely satisfied	64 (73.6)
Somewhat Satisfied	14 (16.1)
Neutral	3 (3.5)
Somewhat Unsatisfied	5 (5.8)
Extremely Unsatisfied	1 (1)
Future of Telemedicine in the Post-Covid Era	
21. Do you agree that telemedicine should be given to patients as an option when taking an appointment in the post-Covid Era?	
Strongly Agree	71 (81.6)
Agree	10 (11.5)
Neutral	3 (3.5)
Disagree	2 (2.3)
Strongly Disagree	1 (1.1)
22. Do you believe that you will be doing more telemedicine encounters?	
Strongly Agree	49 (57)
Agree	17 (19.8)
Neutral	11 (12.8)
Disagree	5 (5.8)
Strongly Disagree	4 (4.6)
23. Do you agree that telemedicine could replace clinic visits in the post COVID-19 era?	
Strongly Agree	16 (18.4)
Agree	17 (19.5)
Neutral	13 (14.9)
Disagree	22 (25.4)
Strongly Disagree	19 (21.8)

3.2.2. Diagnosis

When asked about the frequency of providing diagnosis via telemedicine, 8 (25%) physicians said *always*, 7 (21.9%) said *about half of the time*, 15 (46.9%) said *sometimes*, and 2 (6.2%) said *never*. As for how comfortable physicians are in providing a diagnosis via telemedicine compared to clinic visits, 7 (21.9%) physicians felt *extremely comfortable*, 13 (40.6%) felt *somewhat comfortable*, 2 (6.4%) were *neutral*, 9 (28.1%) felt *somewhat uncomfortable* and 1 (3.1%) felt *extremely uncomfortable* (Fig. 2b). Most physicians *agreed* that telemedicine provided all the information they needed to provide a diagnosis (n = 12, 37.5%), but for the ones who disagreed, *physical examination* was the main thing that telemedicine didn't provide (n = 21, 100%). However, even without a physical exam, when asked if they were ever forced to change a diagnosis after a telemedical session, 8 (25%) physicians *agreed*, 11 (34.4%) were *neutral*, and 13 (40.6%) *disagreed*.



Fig. 2. a. The frequency of technical issues faced by physicians, b. Compliance of patients after the telemedicine encounter; c. Ease of diagnosis via telemedicine; d. Effect of telemedicine on reimbursement.

3.2.3. Follow-up

During the follow-up period, when asked whether their patients were compliant with their instructions after the telemedical encounter, 5 (15.6%) physicians *strongly agreed*, 20 (62.5%) *agreed*, 7 (21.9%) were neutral and none *disagreed* (Fig. 2c). Also, most physicians disagreed to the notion that their patients might have gotten the wrong message because of miscommunication during the telemedical visit (n = 17, 53.2%).

3.2.4. Advantages and disadvantages of telemedicine

For physicians, the main advantage of telemedicine was its convenience (n = 13, 44.8%), followed by the ability to reach more patients (n = 9, 31%), saving time (n = 10, 34.5%) and lastly the protection it provides against infectious diseases (n = 14, 48.3%). As for the disadvantages, physicians believed that the main con was that the remote nature of telemedicine limits their assessment of the patients (n = 23, 76.7%) followed by the probability of losing important information due to electronic glitches (n = 15, 50%) and finally the concern regarding patient data security (n = 21, 70%).

3.2.5. Future of telemedicine in the Post-Covid era

When asked about the possibility of telemedicine in substituting clinic visits in the post-COVID-19 era, 4 (12.5%) physicians *strongly agreed*, 9 (28.1%) *agreed*, 9 (28.1%) were neutral, 9 (28.1%) *disagreed*, and 1 (3.2%) *strongly disagreed*. Also, when presented with the statement that patients should have a choice between telemedicine and clinic visits in the post-COVID-19 era, 7 (21.9%) physicians *strongly agreed*, 17 (53%) *agreed*, 6 (18.8%) were neutral, and 2 (6.3%) *disagreed*. Lastly, 7 (21.9%) physicians *strongly agreed* that telemedicine will have a negative effect on reimbursement, 10 (31.3%) *agreed*, 13 (40.6%) were neutral,

and 2 (6.2%) *disagreed*. (Fig. 2d) Answers are summarized in Table 2.

4. Discussion

The COVID-19 pandemic has taken a substantial toll on countries across the world and tested their healthcare systems. Many countries have adopted lockdown strategies to reduce contact between individuals and lower infection rates, hence “flattening the curve” and conserving capacity in hospitals [5]. While this was the case in the United States, hospital systems and federal and state governments moved quickly to ensure non-covid medical visits shifted towards a virtual landscape [6]. On March 26, 2020, the US federal government passed the Coronavirus Preparedness and Response Supplemental Appropriations Act facilitating the expansion of telemedicine and lifting previous medicolegal barriers [6,7]. For instance, telemedicine visits from nonrural settings and using all video conferencing platforms were eligible for reimbursement [7]. COVID-19 presented us with a societal public health emergency which pushed us to rely on telemedicine techniques that have been prevalent in disaster medicine since the 1980s [8]. Healthcare systems also responded with evident urgency as tele stroke systems were implemented within a week of the declaration of the pandemic in several hospitals in California [1]. All in all, the ease of use, respect of privacy, availability of technology for most patients in our study enabled them to raise their concerns in a clear and smooth manner to their treating physicians who understood, diagnosed, and offered them treatment options.

4.1. Advantages and disadvantages of telemedicine

One of the main criticisms that telemedicine in Neurosurgery

Table 2
Summary of the physician survey results.

Question	N (%)
Overview	
1. On a scale of 1-5, 1 being least skeptical and 5 being very skeptical, how skeptical are you about the idea of using telemedicine as a substitute for face-to-face encounters with your patients?	
1	9 (27.2)
2	9 (27.2)
3	9 (27.2)
4	5 (15.1)
5	1 (3)
2. Are you currently using telemedicine as the sole tool for meeting with your patients or are you using other tools?	
Only Telemedicine	1 (3)
Telemedicine and other tools	29 (87.9)
Other tools	3 (9.1)
3. Do you face more difficulties with telemedicine when it's a new patient or when it is a follow-up?	
New Patient	28 (87.5)
Follow-up	4 (12.5)
4. In which aspect of the call are you, as an attending, having the most problems?	
Technical	26 (81.3)
Miscommunication	4 (12.5)
Duration of the call	2 (6.2)
5. Roughly, in how much percent of your telemedicine encounters where you forced to substitute with a phone call for technical reasons?	
0-25%	19 (59.4)
25-50%	12 (37.5)
50-75%	19 (3.1)
75-100%	0 (0)
Diagnosis	
6. How often are you providing your patients with diagnosis via telemedicine?	
Always	8 (25)
About Half of the time	7 (21.9)
Sometimes	15 (46.9)
Never	2 (6.2)
7. How comfortable are you with providing a diagnosis via telemedicine compared to in clinic?	
Extremely Comfortable	7 (21.9)
Somewhat Comfortable	13 (40.6)
Neutral	2 (6.4)
Somewhat Uncomfortable	9 (28.1)
Extremely Uncomfortable	1 (3.1)
8. Do you believe you have all the info you need to diagnose a patient via telemedicine?	
Strongly Agree	2 (6.3)
Agree	12 (37.5)
Neutral	7 (21.9)
Disagree	10 (31.2)
Strongly Disagree	1 (3.1)
9. If you did not agree to question 8, please choose what lacks in telemedicine to provide a patient with a diagnosis.	
Physical Exam	21 (100)
Imaging	0 (0)
Previous Hospitalization Information	0 (0)

Table 2 (continued)

Question	N (%)
10. Were you ever forced to change your diagnosis after the telemedicine session because you were not provided with the information you needed during the session?	
Strongly Agree	0 (0)
Agree	8 (25)
Neutral	11 (34.4)
Disagree	13 (40.6)
Strongly Disagree	0 (0)
Follow-up	
11. Upon follow-up, do you believe that the patient was compliant with your instructions from the previous telemedicine-visit?	
Strongly Agree	5 (15.6)
Agree	20 (62.5)
Neutral	7 (21.9)
Disagree	0 (0)
Strongly Disagree	0 (0)
12. Upon follow-up, do you believe any of your patients got the wrong message because of miscommunication via telemedicine?	
Strongly Agree	1 (3.1)
Agree	4 (12.5)
Neutral	7 (21.9)
Disagree	17 (53.2)
Strongly Disagree	3 (9.3)
Advantages and Disadvantages of Telemedicine	
13. Can you rank the following pros of telemedicine from most important to least important?	
1. Comfortable and Convenient	13 (44.8)
2. Reach more Patients	9 (31)
3. Saves Time	10 (34.5)
4. Protective Against Infectious Diseases	14 (48.3)
14. Can you rank the following cons of telemedicine from most important to least important?	
1. Limits Assessment	23 (76.7)
2. Loss of Information Due to Electronic Glitches	15 (50)
3. Patient Data Security	21 (70)
Future of Telemedicine in the Post-Covid era	
15. Do you believe that telemedicine can substitute face-to-face encounters in the post Covid-19 era?	
Strongly Agree	4 (12.5)
Agree	9 (28.1)
Neutral	9 (28.1)
Disagree	9 (28.1)
Strongly Disagree	1 (3.2)
16. Do you agree that patients should have a choice between telemedicine and face-to-face encounters in the post-Covid-19 era?	
Strongly Agree	7 (21.9)
Agree	17 (53)
Neutral	6 (18.8)
Disagree	2 (6.3)
Strongly Disagree	0 (0)
17. Do you believe that telemedicine will have a negative effect on reimbursement?	
Strongly Agree	7 (21.9)
Agree	10 (31.3)
Neutral	13 (40.6)
Disagree	2 (6.2)
Strongly Disagree	0 (0)

encounters is the difficulty of administering proper neuroexamination virtually. However, telemedical remote examination using the National Institute of Health Stroke Scale (NIHSS) has been proven to be feasible, effective, and reliable [9]. Teleconsultation, teleradiology, and telethrombolysis were especially effective virtually [9]. Other disadvantages include technological barriers, privacy concerns, patient data security concerns, and a compromised physician-patient relationship [6,10,11]. Legislation also prevents multiple subspecialty practitioners to bill simultaneously for a single patient visit, which constitutes a barrier to patient-centered consolidated care [11]. On the other hand, telemedicine offers numerous advantages in terms of cost-effectiveness, access to care, and convenience [10–13]. There are currently a multitude of systemic challenges plaguing our healthcare system, such as an imbalance in access to care between urban and rural areas. Telemedicine could help bridge this gap, allowing patients in healthcare deserts to be seen by specialists at academic urban medical centers [13]. The economic and clinical benefits telemedicine offers patients alone are immeasurable. With the added convenience and diminished travel-times that telemedicine offers, patients lose less work time, and their financial health is maximized along with their physical health [12,13]. Our study results were in parallel with the literature as Kahn et al. raised several concerns regarding telemedicine including uncertain reimbursement policies, absence of interstate licensure reciprocity, universal imbalance in access to technology and risks of patients confidentiality compromise [12,14]. Moreover, they stated several common advantages and added others such saving travel time and economic loss for patients due to missed work time and providing triage to determine level of care for trauma and acute stroke cases [14–17]. The advantages of telemedicine clearly outweigh its cons and the field of Neurosurgery stands to benefit greatly by incorporating telemedicine in a systemic fashion even after COVID-19.

4.2. Comparison to the literature

A factor that ranked important for neurosurgery patients in the utilization of telemedicine was the cost-effectiveness and quick-turnaround time of telemedicine versus in-person clinic visits. Cost-effectiveness was ranked as the second most important pro of telemedicine. A systematic review performed by Atmojo et al. (2020) found that telemedicine services significantly reduced the cost of care for users to access health services by reducing transportation costs. It also was found to reduce hospital and provider costs by limiting consultation expenses, patient transfer costs, and shortening treatment decision times [18]. This was further underscored in the Hayward et al. study (2019) in pediatric neurosurgery telemedicine patients that found that managing neurosurgery patients and their families via telemedicine saved travel time, travel cost, and time away from work [19]. Thakur et al. (2018) also found that teleconsultation for neurosurgery patients was not only cost-effective, but also cost-saving meaning that the visit itself was of lower cost and higher effectiveness than in-person visits with a 97% efficiency rate [20]. In our cohort, convenience was the single most important factor ranked for the benefits of telemedicine with 49% of patients ranking it as the most important factor. This correlates with studies in the neurosurgical patient cohort by Reider-Demer et al. (2017) and Dadlani et al. (2014) that found that there was high patient acceptance and satisfaction with no statistically significant difference in post-operative outcomes and was an efficient and cost-effective option for those in distant and lower-income patient populations [21,22]. It is important to note that in our survey, only a single telehealth appointment was assessed. A retrospective study by Ashwood et al. found that access to telehealth may have increased the cost of health services contrary to the initial cost-effectiveness, a. An increase in convenience may have tapped into new unmet medical demand and utilization as well as increased utilization as compared to in clinic visits in up to 80% of the patients. The initial decrease in cost may be offset by the overall increase in health care utilization via telehealth through increase access

to care and more frequent care visits due to convenience [23]. Tandon et al. conducted an international survey with 286 patient/physician respondents with similar findings as our study [14]. Most patients perceived telemedicine as an easy, cost-effective, and convenient tool that allows patients to consult multiple specialists while decreasing the risk of contracting COVID-19 in the hospital and most physicians believed telemedicine saves times and provides more efficient patient scheduling which is why they will continue using this tool after the pandemic [14]. Further studies may be needed to conclusively assess long-term effectiveness of telehealth in neurosurgical patients. Our patient cohort also demonstrated that most patients, 95%, did have the technology required for the telemedicine appointment. To our knowledge, this study is one of few that examined the impact of telemedicine on health care professionals in neurosurgery-based practice.

The introduction of telemedicine in patient care affected both patients and physicians and posed several adaptive challenges. This was evident in the physicians' answers when asked about skepticism and comfortability. Logically, the main concern for physicians was the inability to perform a physical exam which somehow affected their confidence in providing diagnosis in the telemedical platform. On the other hand, with respect to the technical aspect of these encounters, physicians seemed satisfied with communication via telemedicine and believed that their patients understood and were compliant with their medical instructions. This has resulted in a positive mentality towards the future of telemedicine which paralleled the literature [24–26]. Acknowledging the advantages of telemedicine and its disproportionate impact on under-resourced settings and vulnerable communities, telemedicine may offer a solution to these populations [27].

This study demonstrates, based on the surveys on neurosurgery patients and physicians, value and satisfaction in telemedicine amongst patients and increased alacrity amongst neurosurgery physicians. It provides additional insights into the experiences and value of telemedicine, which is even more relevant with the reemergence of new variants which is likely to further extend the implemented public health measures. This study doesn't have the power to generalize the results, however, it sheds the light on an important tool that can be used even when COVID-19 perishes. Further studies are required to understand telemedicine uptake amongst patients and physicians, especially in the neurosurgery field, underscoring the importance of convenience and cost-effectiveness in health care delivery.

5. Limitations

The main methodological limitation of this study is that the surveys are not validated instruments. Thus, the results are based on the opinions and perceptions of the respondents and are limited by response bias. Also, the surveys were conducted during the COVID-19 pandemic in which health care professionals were viewed in a very positive light which may have overestimated patients' satisfaction. Finally, because many patients did not consent to participate in the survey, we were left with 93 patients, which affects the generalizability of the study.

6. Conclusion

Telemedicine has become a major force in the health care system under the circumstances the world is witnessing. This technology provides several advantages and poses several drawbacks; however, health care systems must utilize this healthcare delivery and communication tool to provide and expand access to patients with the highest level of care while trying to overcome its disadvantages. Physicians and patients have displayed high levels of satisfaction with telemedicine and believe it may become a major key in providing health care to underprivileged areas in the future. More studies should be conducted with more patients and in different medical fields to assess telemedicine and its impact on healthcare.

Declaration of Competing Interest

Dr. Jabbour is a consultant for Medtronic, MicroVention Cerus Endovascular and Balt. Dr. Tjoumakaris is a consultant for Medtronic and MicroVention. Dr. Gooch is a consultants for Stryker. The other authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

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