The COVID-19 pandemic ushered in unprecedented challenges to healthcare delivery globally. The tremors felt by such disruptions were more pronounced in developing nations owing to the limitations and constraints in existing medical infrastructure, doctor-to-patient ratio, and resource allocation. The impact was limited to not only hospitalized patients but also outpatient clinic services. Additionally, multiple lockdowns, travel and social distancing restrictions, and deployment of healthcare professionals to COVID-19–designated treatment centers truncated outpatient services across the country. This further aggravates the problems of our neurosurgical patients, necessitating the adoption of telemedicine services for outpatient consultations for the first time.1–4

In our earlier paper, we showed that telemedicine was a viable alternative to in-person visits during the COVID-19 pandemic for a select group of neurosurgical patients.5 Based on our initial experience, we realized that a sizable patient population of a developing country such as India

Challenges and prospects of neurosurgical teleconsultations in a developing country: a reality check

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OBJECTIVE The adoption of telemedicine became a necessity during the COVID-19 pandemic because patients found commuting to be difficult owing to travel restrictions. Initially, audio-based teleconsultations were provided. Later, on the basis of the feedback of patients and caregivers, the authors started to provide video-based teleconsultations via WhatsApp. The authors subsequently surveyed the patients and caregivers to determine their satisfaction levels with telemedicine services.

METHODS An anonymized telephone survey of patients who had participated in teleconsultation was conducted with a structured questionnaire. The responses were analyzed and their correlations with the perceived benefits and limitations of audio and video teleconsultation were determined.

RESULTS Three hundred respondents were included in the first round of surveys, of whom 250 (83.3%) consented to video teleconsultation. Among the respondents who participated in both audio and video teleconsultations (n = 250), paired analysis showed that video teleconsultation was perceived as better in terms of providing easier access to healthcare services (p < 0.001), saving time (p < 0.001), and satisfaction with the way patient needs were conveyed to healthcare providers (p = 0.023), as well as in terms of adequacy of addressing healthcare needs (p < 0.001) and consequently providing a higher rate of overall satisfaction (p < 0.001). For both audio and video teleconsultation, overall patient satisfaction was significantly related to only previous exposure to WhatsApp. However, for video consultation, longer call duration (p = 0.023) was an important independent factor. Video teleconsultation was preferable to face-to-face consultation irrespective of educational status, but higher education was associated with preference for video teleconsultation.

CONCLUSIONS Both audio and video teleconsultation are viable cost-effective surrogates for in-person physical neurosurgical consultation. Although audio teleconsultation is more user-friendly and is not restricted by educational status, video teleconsultation trumps the former owing to a more efficient and satisfactory doctor-to-patient interface.

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KEYWORDS telemedicine; teleconsultation; telesurvey; perspective; pitfalls; neurosurgery; video-based consultations; COVID-19 pandemic; WhatsApp; videoconferencing
now has access to smartphones and the internet. Hence, we started to utilize the videoconferencing application of WhatsApp (Meta Inc.) to connect with patients who consented to this service. To understand the perceptions of patients and caregivers about the utility of the audio-only and video-based teleconsultations, we subsequently conducted a telephone survey. This unique study provides a reality check about the perceptions of patients and caregivers regarding the utility of teleconsultations. On the basis of our observations, we have identified the problems and pitfalls faced by developing countries such as ours when implementing these services and have provided our suggestions for improvement.

**Methods**

**Study Design**

Neurosurgical patients participated in telephone consultations as a part of an institutional protocol implemented during multiple waves of the COVID-19 pandemic. This survey study collected feedback about satisfaction with teleconsultation services in neurosurgery during the COVID-19 pandemic. Ethical approval for this study was obtained from the institution’s ethics committee.

The contact information of the neurosurgical patients who utilized audio-based teleconsultation services at our institution from March to May 2021 was retrieved from the medical record department. Patients were contacted again via telephone from June 24 to September 30, 2021, and verbal informed consent for the survey was obtained.

The first round of surveys used a structured questionnaire to obtain feedback from the respondents about the audio consultation that they had participated in via a telephone call. As a part of the first round of surveys, respondents were also asked about their future preferences for video consultation. A video-based teleconsultation via WhatsApp was scheduled for those patients or caregivers who consented. The consultations were provided by neurosurgical residents and attending physicians. The second round of surveys was then used to obtain feedback from the patients and caregivers who participated in the video consultation. To minimize interviewer bias and interpersonal variability, a single neurosurgical resident (N.K.) administered both surveys to all patients. Moreover, the sequence of the questions asked during the telesurvey was randomly altered to prevent question order bias.

**Questionnaire Validation and Data Collection**

Data regarding demographic characteristics, travel time, transportation cost, clinical characteristics, education characteristics, and adeptness using the WhatsApp application/smartphone were initially collected from all respondents after informed consent had been obtained. Two structured questionnaires were prepared using Google Forms (Google LLC), one for audio-based teleconsultation and the other for video teleconsultation, in English and Hindi. These questionnaires were based on the Telehealth Usability Questionnaire, prepared with some modifications, and translated into Hindi.

The first round of surveys consisted of a 2-part questionnaire that collected feedback regarding patient experiences during audio-based teleconsultation. Although part 1 (items 1–9) assessed individual aspects of satisfaction, part 2 (items 10–13) was used to evaluate the overall acceptability of teleconsultation services. Respondents were asked about their experience with the previous teleconsultation and were given the option to participate in a video teleconsultation or a physical consultation for their next appointment. Feedback about their experience during the video teleconsultation was elicited in the second round of the survey, which consisted of items similar to those included in the first round but with the addition of an item about video quality to part 1 of the questionnaire (items 1–10); part 2 remained the same (items 11–14). Preferences for the modality to be used in future consultations were also recorded after both rounds of the telesurvey.

Five independent neurosurgeons from separate institutions, who were not part of the study design, performed face and content validation of the survey questionnaire on a scale from 1 to 4. Based on the feedback provided, scale-level content validity and item-content validity indices were found to have met a satisfactory value of 1.5 To assess the final outcomes of both the audio and video teleconsultations, we asked the respondents to rate their overall satisfaction on the Likert scale from 1 to 10, as well as whether they would recommend the teleconsultation services to other patients and their preferred modality for future consultations.

**Statistical Analysis**

Data were entered in Google Forms and converted to a Microsoft Excel spreadsheet, and statistical analysis was done using Stata statistical software version 16.1 (StataCorp). Categorical data were analyzed using the chi-square test, and the ordinal outcomes were assessed using the Mann-Whitney U-test and Kruskal-Wallis test. Multivariate analysis with ordinal logistic regression was used to assess predictors of overall rating and satisfaction. Pairwise analysis with the Wilcoxon signed-rank test was performed to compare feedback about the audio and video teleconsultations from the subgroup of patients that was contacted via both modalities. A p value < 0.05 was considered statistically significant.

**Results**

Three hundred sixty neurosurgical patients, who were consulted through the telemedicine facility at our institution during the study period, were considered for the survey. Of these, 300 respondents were contacted for the first round of the survey. Of these 300 respondents, 250 (83.3%) consented to video teleconsultation. Most respondents (172 [57.33%]) were awaiting surgery, and a significant proportion of patients (208 [69.3%]) had neurological pathologies. The other diagnostic categories, in decreasing order of frequency, were spinal pathologies (65 patients [21.7%]), hydrocephalus (13 [4.3%]), trauma (9 [3%]), and vascular pathologies (5 [1.7%]). The demographic profile of the patients included age group, sex, educational status, familiarity with WhatsApp, and travel time and money spent per outpatient visit (Fig. 1). Seventy-two of 300 respondents (24%) required more than INR...
5000 (US $70) in travel costs, and 69 (23%) required more than a day for a single physical outpatient department (OPD) visit (Fig. 1D and E).

Consultations were categorized as preoperative (55.9%) and postoperative (44.1%). Patients felt that the doctor understood their needs better (p = 0.053) and that their needs were better addressed (p = 0.058) during preoperative audio teleconsultations than postoperative audio consultation; however, this difference failed to reach statistical significance. Patients had favorable responses for both preoperative and postoperative video teleconsultations. Consequently, there were no statistical differences between preoperative and postoperative perceptions in terms of the doctor understanding the patient’s condition (p = 0.894) and the needs addressed (p = 0.714) via video teleconsultations. The district-level distribution of the patient population is illustrated in Fig. 2.

Feedback About Audio and Video Teleconsultations

Individual aspects of respondent satisfaction (part 1) with both audio and video consultation are summarized in Fig. 3. Overall acceptability was assessed with the second part of the survey. Sixty-four respondents (21.3%) gave excellent ratings for audio teleconsultation, whereas 72 respondents (28.8%) did so for video teleconsultation. In total, 119 respondents (39.7%) felt that audio teleconsultation was a satisfactory way to receive a consultation, whereas 121 respondents (48.4%) felt the same for video teleconsultation. At least half the respondents (151 [50.3%]) reported that they would highly recommend audio teleconsultation, whereas 152 respondents (48.4%) felt the same for video teleconsultation. Two hundred fifty (83.33%) of 300 respondents who received audio teleconsultation said they would prefer video for the next teleconsultation. Thirty-four respondents (11.33%) reported face-to-face consultation and 16 respondents (5.3%) reported telephone consultation as their preferred method for future consultation. Of the 250 respondents who participated in video teleconsultation, 197 (78.8%) also chose video for the next teleconsultation, whereas 53 respondents (21.20%) opted for in-person face-to-face consultation.

Comparison of Audio and Video Consultations

Paired analysis—which was used to assess the respons-
es of those who participated in both the audio and video teleconsultations (n = 250) of the first part of the survey—showed that video teleconsultation was perceived as better in terms of providing easier access to healthcare services (p < 0.001), saving time that would have otherwise been spent visiting clinics physically (p < 0.001), satisfaction with the way patient needs were conveyed to the providers (p = 0.023), and adequacy of addressing healthcare needs (p < 0.001). However, the respondents found audio teleconsultation to be easier to use than video teleconsultation (p < 0.001). There was a trend toward the perception of better understanding of patient needs by the care provider (p = 0.06) during video teleconsultation. Audio quality was perceived as better during audio consultation, but this difference fell short of statistical significance (p = 0.075). There were no significant differences in terms of the perceived pleasantness of the experience talking with the teleconsultation provider (p = 0.923) and the comfort in sharing their needs via either modality (p = 0.606).

Similarly, paired analysis of the results of the second part of the survey showed that video teleconsultation provided a higher rate of overall satisfaction (p < 0.001) and respondents gave a higher overall rating (p < 0.001) to video teleconsultation. Additionally, respondents were more likely to recommend video teleconsultation services to other patients after receiving video teleconsultation compared with audio teleconsultation (p = 0.016). The pairwise analysis is summarized in Fig. 4.

**FIG. 2.** District-wise distribution of respondents who participated in teleconsultation (n = 300).
Factors Affecting Respondent Feedback

The educational status of the respondents and their level of familiarity with the WhatsApp platform were significantly correlated across the majority of the feedback items for both audio and video teleconsultation.

For audio teleconsultation, although overall patient satisfaction was significantly related to only previous exposure to WhatsApp (regularly used vs not used, p < 0.001), overall rating on the 10-point Likert scale was significantly associated with educational status (completed...
degree vs school dropout, \( p = 0.001 \)) and prior exposure to WhatsApp (regularly or seldom used vs not used, \( p < 0.001 \)). Similarly, educational status (completed degree vs school dropout, \( p = 0.004 \)) and familiarity with WhatsApp (regularly or seldom used vs not used, \( p < 0.001 \)) also significantly impacted the overall rating of video teleconsultation. However, longer call duration (\( p = 0.023 \)) was an important independent factor, apart from familiarity with WhatsApp (\( p < 0.001 \)), that was associated with overall satisfaction with video consultation (Table 1). The results of the univariate analysis of feedback responses and other demographic variables are summarized in Fig. 5. We conducted multivariate analysis of overall rating and satisfaction with both audio and video consultations, and the ordinal logistic regression model obtained by backward elimination is summarized in Table 1.

Across all levels of education, video teleconsultation (250 [83.3%]) was the most preferred among respondents, followed by face-to-face (34 [11.3%]) and audio (16 [5.3%]) consultations. However, preference for video teleconsultation increased further with educational status, with 140 respondents (94.6%) with a college degree opting for video teleconsultation (\( p < 0.001 \)). A similar trend was evident when respondents were asked about their preferred consultation modality after completion of video teleconsultation. Although video teleconsultation was preferable to face-to-face consultation irrespective of educational status, the relative proportion of respondents in favor of video teleconsultation was even greater among those with higher educational status (\( p = 0.004 \)). Time taken and money spent per physical OPD visit were not significantly associated with choice of future consultation modality after audio (\( p = 0.151 \) and \( p = 0.113 \), respectively) and video (\( p = 0.388 \) and \( p = 0.399 \)) teleconsultations.

**Discussion**

Because of restrictions on travel and the diversion of...
manpower to COVID-19-designated areas, patients have found it hard to consult their physicians.\textsuperscript{1–5} We cater to more than 100,000 neurosurgical patients per year in our outpatient clinics. We realized that many sick patients were unable to travel, and hence we initiated free telemedicine services for the first time to continue healthcare delivery. Our initial feedback was that most of our patients were from underprivileged backgrounds and audio-based teleconsultations provided them with a viable alternative to seek healthcare at their doorstep. Despite the acceptance of audio-based teleconsultation by most people, we felt that improvement was needed because patient clinical status could not be assessed and elaborate communication was also a challenge owing to language barriers. Incorporation of video-based teleconsultations into our current practice did address some of these needs. We chose to utilize the WhatsApp videoconferencing application because more than 749 million users in India subscribe to it because of its user-friendly interface and free services.\textsuperscript{7}

**Video Versus Audio Teleconsultations**

This unique survey has been a revelation because it has shown that, possibly due to the lack of penetration of 4G internet services into remote areas, audio quality was rated as better during audio consultation than video consultation. Additionally, video quality was rated poorly by a majority of respondents. Moreover, because of poor familiarity with smartphones, many patients found audio consultation easier (74\%) than video consultation (50\%). Despite these challenges, video consultation demonstrated better utility because it saved time, improved perceived access to healthcare services, and improved overall communication, thereby addressing healthcare needs better than audio consultation. This is probably why respondents provided better overall ratings, reported higher overall satisfaction levels, and considered recommending teleconsultation to others after video consultation.

**Factors Affecting Overall Acceptability of Teleconsultation**

The major factors identified as significant predictors of overall rating and satisfaction with both audio and video teleconsultations included educational status and familiarity with WhatsApp. Additionally, the respondents who participated in video calls with a longer call duration reported better overall satisfaction with video consultation. The same did not hold true for audio consultation. However, even those respondents with lower educational status and unfamiliarity with WhatsApp reported a preference for video teleconsultation over face-to-face consultation. This may be attributable to the fact that the majority of our patients have to commute from far-flung areas, which may pose a significant financial burden with respect to their socioeconomic status. Reed et al.\textsuperscript{8} showed that those with higher travel costs and longer travel times prefer teleconsultation. However, these parameters were not significantly associated with overall acceptability of teleconsultation in this study.

**Cost-Effectiveness of Telemedicine**

Telemedicine offers an efficient and cost-effective alternative to traditional practice, particularly if competent care can be provided.\textsuperscript{4,5,9} Our study results echo similar findings, wherein the vast majority of patients felt the positive economic impact of the rendered teleconsultation services. The magnitude of its potential was much more appreciable with video teleconsultation services than the audio counterparts. Moreover, telemedicine has immense potential to transcend geographical barriers, yield productivity gains, and improve the skills of clinicians via telementoring. However, telemedicine programs are unlikely to completely replace in-person consultations as the standard of care, but they may reduce overall costs if carefully selected patients can be treated remotely.\textsuperscript{10} Langabeer et al.\textsuperscript{11} documented $928,000 in annual cost savings from a societal perspective or $2468 savings per avoidance of a single emergency department visit due to the use of telemedicine. However, the relationship between the choice of future consultation modality and travel time or money spent per physical OPD was not observed in this study. This may be attributable to the fact that more than three-fourths of patients were residing in adjacent regions. Travel time for these patients was less than 1 day, and expenditures were less than US $70 (approximately INR 5000). This may have limited the power of the current analysis to detect the impact of these confounding variables on preference for audio and video teleconsultation with respect to face-to-face consultation.

**Telemedicine in India: Pitfalls and Solutions**

There has been an exponential rise in telemedicine consultations during the COVID-19 pandemic. During multiple nationwide lockdowns of this pandemic, we have intermittently resorted to telemedicine for follow-up of neurosurgical patients. However, in the pre–COVID-19 era, we did not have any experience with the same modality. The legal framework in our country was not initially equipped to deal with litigation arising from such practice. Therefore, the Medical Council of India amended the Indian Medical Council (Professional Conduct, Etiquette, and Ethics) Regulations, 2002, and provided new telemedicine practice guidelines in 2020.\textsuperscript{12} This provided a much-needed impetus for physicians and surgeons to provide teleconsultation services in our country. Following this, the Insurance Regulatory and Development Authority of India (IRDAI) also directed health insurance providers to settle claims for teleconsultations,\textsuperscript{13} thereby further streamlining the reimbursement-related issues with this virtual healthcare-delivery service.

Telemedicine services in public sector hospitals in India are provided free of cost to the patient, and no remuneration is provided to the treating physicians. Digital illiteracy, lack of high-speed internet connectivity, and low socioeconomic status consequentially resulting in inaccessibility to smartphones were some reasons for circumventing video-based teleconsultation in our study. Improved penetration of 4G/5G services, education status, and patient income are likely to address some of these issues in India.\textsuperscript{14–18} Patients were unable to reach the hospital owing to lockdown, and telemedicine services were started on an emergency basis to help needy patients. Health Insurance Portability and Accountability Act (HIPAA)–compli-
ant software for telemedicine use was unavailable to us. We chose WhatsApp because it is free, has a very large subscriber base, has a user-friendly interface, and has enhanced security due to end-to-end encryption of chats or calls. We have realized that privacy concerns cannot be addressed completely with this application. Therefore, to safeguard medical practitioners from legal implications, we recommend the use of HIPAA-compliant software for telemedicine. Preferably, the application should be integrated with the hospital’s electronic medical record system because this allows easy collation of data for future reference. This further enhances the safe practice of telemedicine services and allows for central record keeping to maintain proper documentation and avert future medicolegal mishaps.

This was the first survey of its kind from the Indian subcontinent that attempted to understand the perceptions of patients and caregivers regarding teleconsultation services, as well as to compare audio and video teleconsultations in a developing country with unique challenges with respect to access to technological advancements. Physical examination has been an essential component of most clinical specialties, including neurosurgery. Thus, the lack of physical examination is a major concern against the use of telemedicine services. Several novel solutions such as standardized guidelines for patient-assisted virtual examination and utilization of gadget-based health sensors have been proposed. A similar but specific system is needed for telemedicine. In our country. However, as a public tertiary care referral hospital, we mainly cater to patients in the middle and lower socioeconomic strata. These patients have limited access and familiarity with telemedicine-related technological advancements. Therefore, the prospects and limitations of the telemedicine services provided by our institution are representative of the challenges faced by a developing nation and offer a replicable model for other centers in low- and middle-income countries. Although the survey questionnaire was developed to capture the true essence of the patients’ perspectives and pitfalls regarding teleconsultation services in a developing nation, the slim odds of acquiescence bias confounding the study results still remain and possibly stem from the fabric of our society, wherein doctors and care providers are highly regarded and well respected by communities at large.

Conclusions

Both audio and video teleconsultations are viable cost-effective surrogates for in-person physical neurosurgical consultations, even in developing countries. Although audio teleconsultation was perceived as more user-friendly and was not restricted by educational status, video teleconsultation trumps the former due to a more efficient and satisfactory doctor-to-patient interface.

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**Disclosures**

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

**Author Contributions**

Conception and design: Tandon, Katiyar, Praneeth, Sharma, Narwal, Raheja, Mishra, Garg, Suri, Chandra, Kale. Acquisition of data: Tandon, Kumar, Praneeth, Narwal, Garg, Suri, Chandra, Kale. Analysis and interpretation of data: Katiyar, Sharma. Drafting the article: Kumar, Katiyar, Praneeth, Sharma. Critically revising the article: Tandon, Katiyar, Sharma, Raheja, Chandra, Kale. Approved the final version of the manuscript on behalf of all authors: Tandon. Statistical analysis: Katiyar, Sharma, Narwal, Mishra. Administrative/technical/material support: Kumar, Katiyar, Raheja, Mishra, Suri, Chandra, Kale. Study supervision: Raheja, Mishra, Garg, Suri, Chandra, Kale.

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