“But it's a nice compromise” – Qualitative multi-centre study of barriers and facilitators to acute telestroke cooperation in a regional stroke network

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Abstract

Background: Telemedical services can be used to complement on-site services when demand for specialists exceeds supply or when specialists are not evenly distributed across health systems. Using stroke as an example, this study aimed to explore how patients and staff experience telesstroke cooperation in a stroke network in Germany.

Methods: We conducted a qualitative multi-method and multi-centre study combining 32 non-participant observations at one hub and four spoke hospitals with 26 semi-structured interviews with hub and spoke staff as well as stroke patients and relatives. Observation protocols and interview transcripts were analysed to identify barriers and facilitators to telesstroke cooperation from the perspectives of staff, patients and relatives.

Results: In terms of barriers to telesstroke cooperation, we found technological problems, providing the treatment for one patient from two sites, competing priorities between telesstroke and in-house duties in the spoke hospitals, as well as difficulties in participating in the teleneurological examination via a videoconferencing system for older and disabled patients. In terms of facilitators, we found an overall very positive perception of telesstroke provision by patients, good professional relationships within the network, and sharing of neurological expertise to be experienced as helpful for telesstroke cooperation.

Conclusions: We recommend better integration of telemedical services into the care pathway, fostering relationships within the network, improved technological support and resources, and more emphasis within networks, in public awareness efforts as well as in academia on the evaluation of telemedical services from the perspectives of patients and relatives, especially older patients and patients with disabilities.

Keywords
neurology, qualitative research, stroke, telemedicine, thrombectomy
BACKGROUND

Health outcomes following acute ischaemic stroke treatment are highly time-dependent: the sooner patients access treatment, the better their chance of survival without disability. However, treatment access can be challenging especially in rural areas [1–3]. In addition to stroke unit treatment, acute treatment options include intravenous thrombolysis (IVT) to dissolve the blood clot medically, and endovascular thrombectomy (EVT) to remove the blood clot mechanically [4–8]. While IVT can be provided at all hospitals with a stroke unit, EVT is only available at hospitals with a more specialized infrastructure.

Most high-income countries operate health systems which ensure that stroke units can be reached on time within a defined geographical area. As this requires a 24 h/7 d availability of specialized staff, more remote locations (spokes) may opt to integrate their stroke unit within the on-site internal medicine department and receive teleradiology services from neurologists located at specialized hospitals (hub) [9–15]. In Germany, there are currently 22 active networks with different models of telestroke provision, including 24 h/7 d or partial coverage during night and weekend shifts, networks with one or several hubs or telemental and telenueradiological services provided by the same or different hubs [9,16]. Before EVT became part of routine care, interhospital transfers after teleconsultations were rare (e.g., only for severe stroke requiring hemicraniecotomy or neurosurgical interventions). After 2015, EVT necessitated adding emergency transfers from spoke to hub, admitting and treating patients at the hub emergency department, thrombectomy suite, stroke unit and/or intensive care unit, and, in many cases, referring patients back to the original spoke. As a consequence, patients and remote neurologists would more frequently meet in person instead of only interacting remotely.

Given these profound changes to the interactions between hub and spoke staff and patients, this study aimed to explore their experiences in terms of barriers and facilitors to telestroke cooperation in a regional hub and spoke network in Germany. In addition to providing insights for improved acute stroke treatment, the study objective was to help inform initiatives for increased digitalization and remote consultations for other neurological and acute conditions, as currently made more urgent by the SARS-CoV-2 pandemic.

METHODS

We report a qualitative multi-method study combining non-participant observations and semi-structured interviews, conducted as part of a multi-centre evaluation of a German stroke network [17]. Qualitative methods are particularly useful for studies aimed at discovering reasons for observed patterns and answering questions of why, when and how interventions do (not) work as intended [18]. The theoretical framework is based on the COMIC Model for comprehensive evaluations of complex health care interventions emphasizing the importance of context factors and mechanisms for outcome attainment [19]. Within this model, barriers and facilitors are defined as factors hindering or fostering the implementation and execution of an intervention in practice [19–22]. Here, this refers broadly to the network-based telestroke cooperation between EVT and IVT hospitals. We followed the Standards for Reporting Qualitative Research guidelines [23]. Ethics approval was obtained from the ethics commission of the Medical Faculty of Heidelberg University (S-682/2017). Interviewees provided informed consent before participation.

Setting

The study site was the regional stroke network “FAST” (www.fast-schlaganfall.de) which covers parts of three federal states in southwest Germany. Within FAST, teleradiology consultations are provided by one EVT-capable hub to seven IVT-capable spokes.

Data collection

Recruitment and data collection took place at the hub and four of the spokes in two consecutive phases: (1) from March to June 2018 at the hub and (2) from April 2019 to September 2019 at the spokes. Spokes were selected from the available FAST hospitals to ensure heterogeneity based on criteria such as federal state, catchment area, hospital and stroke unit size, personnel resources and availability of telestroke service. Due to data protection requirements no further information can be provided on each hospital.

Observations

During observations at the hub, researchers took notes on the physical layout, people involved, activities observed, personal interactions, sequencing of events and (where possible) the emotions expressed. For the spokes, notes were taken afterwards to avoid impressions of external “quality checks”. Field notes were transcribed into consolidated protocols.

Interviews

We used a purposive sampling method and stepwise recruitment process to recruit at least one interviewee from each profession or ward involved in acute stroke treatment for staff interviews, and covering all main steps of acute stroke treatment for patient and relative interviews (e.g., receiving IVT and/or EVT; admission at spoke and/or hub, different transfer modes, teleconsultation) and demographics and illness characteristics such as age, sex and stroke severity. We used semi-structured interview guides adapted to different professional backgrounds and experiences gained during the interviews. Pilot interviews were conducted with members of
a stroke self-help group. Interviews with patients and relatives were conducted approximately 1 month after the stroke episode.

Data analysis

All observations and those interviews covering expertise (staff) or experiences (patients and relatives) with teleconsultations were considered for analysis. Coding was conducted using MaxQDA-software (2018, VERBI) and included open coding (informed by the theoretical framework), followed by axial and selective coding to identify barriers and facilitators to telestroke cooperation. Here, we looked at the phase starting at admission to the spoke, covering the initiation of the consultation process with the remote neurologist, until the decision was taken to remain at the spoke or to transfer to the hub for further (EVT) treatment.

Patient and public involvement

Members of a local stroke self-help group provided advice on the research design and within the scope of pilot interviews. Preliminary results were discussed with the Patient Council of the Department of Neurology at Heidelberg University Hospital on 23 March 2021.

RESULTS

In total, 32 observations were conducted (median duration 165 [IQR 39–159] min) at the emergency rooms, (neuro-)radiology departments, imaging facilities, stroke units and intensive care units of the hub and spokes. We included 19 staff interviews (median duration 57 [IQR 42–65] min) as well as 7 patient and relative interviews (median duration 48 [IQR 35–73] min). Staff interviews included hub and spoke physicians (neurologists and internists), nurses and therapists. All patients included in this study were first admitted at a spoke where the teleconsultation took place. Most patients had no or moderate pre-existing disabilities as indicated by a median pre-stroke modified Rankin score (prestroke mRS) of 1 (IQR 0–2). The mean National Institutes of Health Stroke Score (NIHSS) at admission was 5.3 Standard Deviation (SD 2.4). Mean NIHSS at discharge was 2.5 (SD 2.2) while median mRS at discharge was 2 (IQR 1–3). Three patients and one relative were female; median age was 69 years, ranging from 32 to 86 years.

Barriers

Barriers were found in the areas of technological problems, providing treatment for one patient from two sites, competing priorities between telestroke versus in-house duties in the spoke hospitals, and difficulties for specific patient groups to participate in teleconsultations (see Table 1 with exemplary quotes).

Technological problems

Technological problems were among the most frequently described and observed barriers in hub and spoke interviews and observations. They mostly related to the camera/video, audio/microphone and the videoconferencing software not working, slow or interrupted internet connection and slow computed tomography image transfers from spokes to hub (Quotes 1, 2). Physicians appeared to be used to these problems and to implement back-up strategies as a matter of routine, including pre-emptive system reboots or using their regular telephones instead of the system audio. Moreover, several staff did point out their overall satisfaction with the IT, stating that problems occurred relatively infrequently, and summarizing that “[as] long as everything is working, it’s good” (Interview 11, nurse, spoke 2).

A smaller number of spoke interviewees pointed out that even when the technology worked as intended, they felt that it could not adequately replace all in-person interactions (e.g., when it is unclear which neurological problems they are concerned with). One spoke interviewee also mentioned that having a neurologist on-site would provide emotional support to less experienced physicians, especially during night shifts.

One patient and two relatives remembered the technological quality of the teleconsultation. The patient stated that it was good enough for her to “immediately recognise [the physician]” when she arrived at the hub (Interview 20, patient), and a relative reported that she could understand everything and was “even able to speak with [the remote neurologist]” (Interview 22, relative). The other relative described some problems with the connection at the beginning but that the physician had handled it well.

Treating one patient simultaneously at two different hospitals

Since the patient’s stroke treatment is effectively provided at two hospitals at the same time, a variety of activities is carried out and coordinated in parallel. Communication channels used include telephone, fax, imaging transfers, and the synchronous video-audio connection via the telestroke system. Fax is used by spokes for formally requesting teleconsultations, while telephones are used for all types of physician-to-physician communication both within and across hospitals, including informally announcing teleconsultations before official fax requests. The imaging transfer system is used to send the clinical images from spoke to hub (neurology and neuro-radiology) and the synchronous video-audio connection via the telestroke system is used for the actual teleconsultation during which the patient is also present. Communication partners include remote neurologists, spoke physicians, (neuro-)radiologists at both hospitals and, “in the background”, the respective department teams including nurses, radiographers, senior and consulting physicians, emergency services personnel and others. Both hub and spoke staff reported the coordination of these parallel pathways as a perceived additional burden, giving them less freedom in organizing the treatment of their
non-telestroke patients (see also later), and leading to feelings of stress. Moreover, spoke staff thought that given these additional coordination activities, teleconsultations take longer than treatment by on-site neurologists. In this regard, they reported a discrepancy between what was perceived to be acceptable with on-site compared to remote treatment, which was discussed in terms of patient outcomes as well as official stroke care quality requirements. At the same time, many spoke staff described this as a necessary compromise given the reality of limited health system resources (Quotes 3, 4).

Balancing telestroke versus in-house duties

Spoke interviewees reported experiencing difficulties in balancing the often time-consuming treatment of stroke patients with their non-stroke patients. For example, they described the perceived impact of the physician being unavailable to their on-site patients and on-site team for considerable amounts of time (Quotes 5, 6). Several interviewees’ statements to this effect hinted at stroke patients competing for time with the spokes’ perceived “real” patients. This balancing act of competing duties was often described against a general backdrop of staff shortages and high caseloads making it even more challenging to run an adequate stroke service with a team whose primary specialization is not neurological care. A similar balancing act was described for the hub when there was a need for coordinating parallel teleconsultation requests from several spokes.

Specific patient groups

Replacing in-person by technology-supported communication was reported and observed to be challenging for specific patient groups including older or disabled (especially hard-of-hearing) patients. According to spoke physicians and one patient with a

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**TABLE 1** Barriers to telestroke cooperation with exemplary quotes

| Barrier                                      | Quotes                                                                                                                                                                                                 | #  |
|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Technology                                   | *Sometimes [the teleneurologist and spoke physician] speak at the same time, and [...] the audio connection is lost or there is a feedback noise [...] of the spoke physician’s voice. Both physicians repeatedly say that they were not able to hear something. There is random noise in the connection [...].*  [Observation 32, spoke hospital 3]  | 1  |
|                                              | *“From this moment on, [the teleneurologist] refreshes the [image transfer interface] every minute. Additionally [the teleneurologist] tries to access the patient’s CT images from other computers. [...] [The teleneurologist] calls the [spoke hospital] again to check whether they uploaded the CT images to the system. [The spoke physician] confirms this. They agree to do the teleconsultation without the CT images.”* [Observation 14, hub hospital] | 2  |
| Treating one patient at two different hospitals | *“What is maybe negative – but we can’t have 70 teleneurologists – if [the teleneurologist] [...] has to take care of four strokes from the region at the same time, then [...] you just can’t act faster.”* [Interview 12, physician, spoke hospital 2] | 3  |
|                                              | *“But it’s a nice compromise, because otherwise where would all the patients go? If they all went [directly] to the [hub] hospitals, [...] they would be so overrun that they would not be able to keep within the time limits, either.”* [Interview 7, physician, spoke hospital 1] | 4  |
| Balancing telestroke vs. in-house duties      | *“If we have a neurological patient, [...] my internist is away from the [clinic] for 45 min. [...] We sometimes have 10, 15 internal medicine patients [who ask]: “Why is nothing happening? When is the doctor finally coming?” If a patient is feeling really bad, [...] I will run [into the teleconsultation room] and say: “Hey doctor, come out, I have a patient here who is feeling bad.” [...] But it is difficult to explain [...] to the relatives or patients [...]”* [Interview 11, nurse, spoke hospital 2] | 5  |
|                                              | *“When you’re in a teleconsultation, you can’t do anything else. I think that’s the main problem for us [...]. The whole clinic is on hold, the whole hospital is on hold, [in the middle of the night] when a [stroke patient] arrives because you’re in the trauma room and you can’t leave.”* [Interview 12, physician, spoke hospital 2] | 6  |
| Specific patient groups                       | *“[It was] exhausting. [...]. Because I need natural acoustics and more visuals [...]. Fortunately, my wife was there and she told me what [the teleneurologist] was asking.”* [Interview 21, patient] | 7  |
|                                              | *“Usually, the [teleneurologist] asks their questions and I yell them in [the patient’s ear].”* [Interview 19, physician, spoke hospital 4] | 8  |
|                                              | *“You can tell younger people it’s like Skype. [...] But with older people you have to point and say: There’s a screen, and there’s the [teleneurologist], and you have to speak into this microphone.”* [Interview 5, physician, spoke hospital 1] | 9  |
hearing impairment, some patients require "[louder] repetition by spoke physicians or relatives" (Quotes 7, 8). Additionally, spoke staff reported that there is often only limited time to inform patients and relatives about the upcoming teleconsultation and, that even if there is, older patients would still not always understand (Quote 9). One patient and relative remembered that the spoke had announced the teleconsultation, explaining that the remote neurologist would be patched in from the hub because of their expertise in stroke, while a different patient and relative remembered that it had not been announced but that they had still been able to make sense of the situation.

**Facilitators**

Facilitators were found in the areas of (perceived) patient satisfaction, good professional relationships within the network, and sharing of neurological expertise (see Table 2 with exemplary quotes).

**(Perceived) patient satisfaction**

Patient and relative interviews showed a very positive perception of teleconsultations, with interviewees expressing surprise and enthusiasm at the possibilities of modern technology, admiration for remote neurologists, understanding that not every hospital could have every type of expertise at all times, and gratitude that this option was available to them (Quotes 10, 11). One patient and his wife summarized the experience as "different [than expected], but good" (Interview 26). As indicated earlier, the exception was the patient with a hearing impairment who reacted less enthusiastically but who also described telestroke as an acceptable compromise (Quote 12).

Spoke staff also reported that teleconsultations are generally received very positively by their patients, mentioning that they seemed happy about the availability of modern technological solutions and that such an effort was made to provide them with the best possible expertise (Quotes 13, 14). Others reported more neutral reactions, also depending on how the necessity and benefits were presented to patients (Quote 15).

**Good professional relationships within the network**

Interviewees reported overall good professional relationships within the network allowing for effective cooperation across hospitals. Difficulties, for example in terms of perceived disrespectful communication styles, were described as exceptions, usually depending on individual characteristics, including inexperience, or situational factors, such as busy night shifts. One hub physician stressed the importance of getting to know spoke colleagues in person and imagined that case conferences could be useful learning and team-building opportunities. This sentiment was echoed by spoke interviewees who pointed out physician rotations between hub and spokes as particularly beneficial to cooperation (Quote 16).

**Sharing of neurological expertise**

Related to the topic of good relationships and cooperation, it was reported and observed that telestroke observations were seen as opportunities to share neurological expertise with spoke hospitals. Examples included remote neurologists explaining to spoke physicians how to assess the visual field, support with blood pressure management or assessing visual extinction phenomena, and spoke physicians checking back with remote neurologists whether they had implemented instructions correctly. However, there seemed to be inconsistencies in the perception of whether the hub’s neurological expertise should also be shared outside the scope of acute and/or stroke referrals, with a hub physician arguing against this practice as opposed to a spoke physician emphasizing it as a positive feature of the network (Quotes 17, 18).

**DISCUSSION**

We reported a qualitative multi-method, multi-centre study investigating barriers and facilitators to telestroke cooperation in a regional stroke network from the perspectives of hub and spoke staff, patients and relatives. While barriers were reported in the areas of technological problems, providing the treatment for one patient from two sites, balancing telestroke versus in-house duties in the spokes, and telestroke provision to specific patient groups, facilitators were found in the areas of (perceived) patient satisfaction, good professional relationships within the network, and sharing of neurological expertise.

**Barriers**

Technological barriers were also reported in other studies but, as in ours, they were generally not perceived as disrupting telestroke provision to an actually harmful extent [24,25]. Similar to our findings on providing the stroke treatment from two sites, others also found telestroke cooperation to add an additional layer of complexity [25–28]. Contrary to our reports of difficulties in balancing in-house (and "real" patients) with telestroke duties, Singh et al. found team cohesion within the virtual hub to be on par with on-site teams [27]. Our findings regarding specific patient groups were also reported by Gibson et al., with some participants perceiving telestroke as detached and not allowing for the same degree of interaction with physicians. Their sample included patients with aphasia and a visually impaired patient who also emphasized the need for additional efforts to involve them in the consultation and provide clearer explanations. Telestroke provision was also found to be more challenging for older patients, particularly those without prior experience with videoconferencing [25].
Our main facilitator related to the positive perception of telestroke provision by patients and relatives, as expressed by themselves as well as hub and spoke physicians. We are aware of only the Gibson study which directly asked patients and carers about their experiences with acute teleconsultations. Respondents also described telestroke in highly positive terms, including “brilliant”, “wonderful”, “fantastic” and “amazing” [25]. However, since the study was conducted prior to EVT, it is unclear how these experiences would

| Facilitator                                    | Quotes                                                                                                                                                                                                 | #  |
|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| (Perceived) patient satisfaction             | “I thought this can only be a good thing. They want to know exactly what is going on with me.” [Interview 25, patient]                                                                                       | 10 |
|                                               | “[The teleneurologist] […] was very empathetic. […] He calmed me down. […] [Later, he] […] met us at the entrance [of the hub hospital] and told us: ‘I spoke to you on the screen and I discussed [your case] with [the spoke physician].’ […] It was reassuring to me.” [Interview 20, patient] | 11 |
|                                               | “I would prefer for a doctor to be present in person. But if there is no other way […], as a second option, [it’s] not a bad idea.” [Interview 21, patient]                                              | 12 |
|                                               | “Yes, many patients tell me [about the tele-consultation]. […] ‘I talked to the doctor on the screen and he assessed me THROUGH the screen.’ They think it’s cool [laughs].” [Interview 13, physician, spoke hospital 2] | 13 |
|                                               | “I see [the patients] during morning rounds. [They tell me]: ‘I was on TV today’ [laughs]. I don’t know of any negative reactions. And it’s well-received that it’s [provided by the hub hospital]. [They tell me]: ‘Well, the professor from [the hub hospital] told me that I’ll be having an MRI today.’” [Interview 7, physician, spoke hospital 1] | 14 |
|                                               | “Most people do not care, in the sense that they are happy that someone helps them. And when you explain to them that it saves a lot of time, instead of traveling by road for 45 min, most will understand. Either they won’t understand, or they’ll see it as having saved time.” [Interview 12, physician, spoke hospital 2] | 15 |
| Good professional relationships              | “[…] People who rotate to us will learn to understand the workings of a small hospital, and to be more relaxed or friendlier on the phone. […] I think it’s a good thing, […] that people know each other.” [Interview 12, physician, spoke hospital 2] | 16 |
| Sharing of neurological expertise             | “One of the downsides of this system is that nowadays we do not only provide tele-consultations for [stroke patients], but everything that is even remotely [related to neurology] […]. It was intended for consultations for acute neurological complications, but now [we get] headaches since 3 weeks, vertigo since 5 years. Everything is dragged in front of [the camera], around-the-clock, and that’s not okay.” [Interview 3 physician, hub hospital] | 17 |
|                                               | “[It’s nice] that you can sometimes call [the hub hospital] and say: ‘It’s not stroke-related, but I need neurological help.’ That you can get that help even if it’s three in the morning.” [Interview 12, physician, spoke hospital 2] | 18 |
translate to current telestroke practices, such as our respondents reporting the positive experience of meeting their remote neurologist in person after being transferred from spoke to hub. Our facilitator relating to good professional relationships was discussed in various studies [24,27]. For example, while Shae et al. found that developing relationships with the spoke hospitals helped ensure spoke physicians’ trust in remote neurologists [29], Bagot et al. conversely reported concerns regarding confidence in the diagnostic skills of unknown colleagues as a barrier to cooperation [28]. Our finding that sharing neurological expertise was perceived as beneficial was also reflected in an overview of telestroke services in Norway [30]. In a more pragmatic take, Uscher-Pines et al. reported that some spoke physicians supported the telestroke service mainly because it allowed them to share liability with the remote neurologists [26].

SARS-CoV-2 pandemic

We are aware of several studies both nationally [31–33] as well as internationally [34–37] reporting declines in stroke incidence and/or telestroke consultations during government-mandated lockdowns. As our data collection ended before the SARS-CoV-2 pandemic began, we cannot provide direct insights as to how our findings might have changed during 2020 and 2021. Speaking for the US, Guzik et al. stated that one of the lessons from the pandemic for telestroke services should be to maintain reimbursements and reduced regulatory burdens [38], which we see mirrored in several of the barriers reported here.

Limitations

First, being part of a larger evaluation, data collection was not exclusively focused on telestroke which meant that only a small number of hub staff and patients and relatives with experience of teleconsultations were included in the sample. This was compensated with a larger number of hub observations and adding staff reports of patient perceptions. Second, there were signs at the spokes that researchers were sometimes believed to carry out quality checks. Despite efforts to clarify roles and make data collection less intrusive, it is possible that spoke interviewees under-reported barriers or dissatisfaction related to the hub. Similarly, as the patient sample showed good recovery from stroke, gratitude towards their treating hospital(s) may have resulted in positive evaluations of their treatment. Lastly, we did not check for the objective accuracy of interviewees’ reported impressions. For example, if staff reported perceived delays in telestroke compared to on-site treatment, we did not match this to quantitative performance data, as this study concerned a purely qualitative evaluation. Patients treated with teleconsultations are subject to the same quality oversight as implemented for all stroke patients treated at hubs and spokes. Future assessments could combine both sources in mixed methods designs for more comprehensive evaluations. To our knowledge, our study is one of the few qualitative evaluations of telestroke cooperation, and the only one carried out after EVT became part of routine care which includes hub and spoke staff, patients and relatives as well as observations and interviews from the same telestroke service.

Recommendations for research and practice

Our results suggest that telestroke is often conceptualized as replacing the in-person neurological assessment by remote technology. Instead, our main practice recommendation would be to understand telestroke as affecting the entire stroke pathway. This would emphasize the necessity of better integrating remote services with all aspects of on-site treatment including technology, involvement of on-site teams or building team cohesion across hospitals. Examples could include network activities, such as training of spoke staff, case conferencing and personal liaising, as well as professional and financial recognition of the additional time and professional skills needed to facilitate remote consultations, especially against the general backdrop of staff shortages and caseloads affecting the care trajectory beyond the teleconsultation. Moreover, this would include emphasis on technological barriers in proportion to their importance to this type of care provision. While our results suggest that staff are capable of implementing compromises that work despite rather than because of the IT systems, some of the reported technological problems appear to have relatively easily implementable solutions. These could include using assistants for system checks, reboots and smaller IT fixes, using multiple and/or Bluetooth-based microphones on the spoke side of the consultation for easier access by patients and relatives, and standard provisions for disabled and older persons. Picking these lower-hanging fruits could then free up resources to tackle the more structurally embedded barriers in the longer run. Last, evaluations of telestroke services seem to be less focused on user experiences, especially from the perspectives of patients and relatives. Instead, improvement efforts should include (representatives of) patient groups who have been found to experience difficulties accessing and engaging with telestroke services, including patients with less previous exposure to video-conferencing and patients with disabilities. Additionally, it could be beneficial to invest in public awareness efforts to remove potential reservations pre-emptively before they are experienced first hand. Lastly, it should be explored to what extent the solutions proposed here can also be of benefit for the telemedical service for other neurological conditions.

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CONFLICT OF INTEREST
The authors declare no conflicts of interest related to this study.

AUTHOR CONTRIBUTIONS
Loraine Busetto: Conceptualization (lead); Data curation (lead); Formal analysis (lead); Investigation (lead); Methodology (lead); Project administration (lead); Writing-original draft (lead). Melek Sert: Data curation (equal); Formal analysis (equal); Methodology (equal); Project administration (equal); Writing-review & editing (equal). Franziska Herzog: Data curation (equal); Formal analysis (equal); Methodology (equal); Project administration (equal); Writing-review & editing (equal). Johanna Hoffmann: Data curation (equal); Formal analysis (equal); Methodology (equal); Project administration (equal); Writing-review & editing (equal). Hemasse Amiri: Writing-review & editing (equal). Fatih Seker: Writing-review & editing (equal). Jan Purrucker: Writing-review & editing (equal). Sibu Mundiyanapurath: Writing-review & editing (equal). Peter Arthur Ringleb: Writing-review & editing (equal). Simon Nagel: Writing-review & editing (equal). Martin Bendszus: Writing-review & editing (equal). Wolfgang Wick: Supervision (equal); Writing-review & editing (equal). Christoph Gumbinger: Conceptualization (equal); Formal analysis (equal); Investigation (equal); Methodology (equal); Supervision (lead); Writing-review & editing (lead).

DATA AVAILABILITY STATEMENT
No data are available. As per the ethics stipulations, we cannot provide access to observation protocols and interview transcripts. Reuse outside the research team is also not permitted as per the ethics committee’s stipulations.

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