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Clinic to in-home telemedicine reduces barriers to care for patients with MS or other neuroimmunologic conditions

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Abstract

Objective

To describe the routine use of telemedicine-enabled neurologic care in an academic outpatient MS and neuroimmunology clinic and quantify its role in reducing patient burden.

Methods

Between January 2017 and December 2017, we surveyed patients and MS neurologists after 50 consecutive routinely scheduled televideo visits and a convenience sample of 100 in-clinic visits. Summary statistics were calculated and comparisons performed.

Results

Overall, 98% televideo participants found the technology easy to use, and only 17% believed that an in-person examination would have more effectively addressed their needs for the visit. MS neurologists reported achieving their clinical goals in 47/48 (98%) of televideo visits and an adequate physical examination with 2 exceptions (possible cauda equina syndrome and visual field loss). Three emergency department referrals were avoided due to televideo availability. Telemedicine reduced travel burden, including a mean (±SD) travel distance of 160 (±196) miles and avoiding overnight lodging and air travel. Telemedicine also reduced indirect costs, including time off work (65% of employed patients) and caregiver burden (30% avoided caregiver time off from work/obligations). Across 8 domains of provider interpersonal communication skills, telemedicine and in-clinic participants rated only 1 domain to be different (eye contact), and overall, 96% of in-clinic and 100% of telemedicine participants agreed/strongly agreed that their clinical goals had been met.

Conclusions

When incorporated as part of the continuum of MS/neuroimmunology care, clinic to in-home telemedicine reduces travel and caregiver burden and enables efficient, convenient, and effective follow-up.

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Glossary

EDSS = expanded disability status scale.

For people living with a chronic neuroinflammatory disease such as MS, medical appointments can represent one of many "hassles of daily life"[1] and have hidden financial and opportunity costs. Various models of telemedicine have been trialed to improve MS care, especially in the realm of rehabilitation,[2] symptom management,[3] and care coordination.[4] In the US, hospital-to-hospital telemedicine models using a trained provider with the patient at the bedside have matured into an important part of the care model for acute stroke[5] and some other Veterans Affairs telemedicine solutions.[6,7] There is emerging interest in using at-home telemedicine visits to augment or possibly replace in-person clinic visits for management of other chronic neurologic conditions, such as Parkinson disease.[8] Telemedicine is part of a larger movement in medicine to promote patient-centered care by developing viable alternatives to traditional in-clinic appointments while preserving the fundamental patient-doctor connection.[9]

The application of in-home telemedicine as part of routine clinical care of the patient with MS and other neuroinflammatory conditions remains under-explored.[10] For the past 4 years, the UCSF MS and Neuroinflammation Center has routinely provided clinic to in-home televideo appointments for established patients. Here, we report on this experience and determine whether the routine use of telemedicine-enabled neurologic care reduces patient and provider burden.

Methods

Setting and participants

We invited UCSF MS and Neuroinflammation Center clinic patients scheduled for clinic to in-home telemedicine visits with each of 5 participating MS neurologists to complete an electronic survey about their visit. Neurologic visits occurred via telemedicine for patients living in California using a secure, web-based teleconferencing platform (zoom.us). Participants were adults (aged ≥18 years) and carried a range of neurologic diagnoses, including MS, neuromyelitis optica spectrum disorder, and other neuroinflammatory disorders (e.g., autoimmune encephalitis and neurosarcoidosis). Participating neurologists were all MS/neuroimmunology experts and at study onset had variable experience with telemedicine in their clinical practice (range 10–100 estimated previous visits, representing between <5% and 40% of a clinician's total weekly scheduled clinical encounters). Patients were consecutively contacted for participation by email by the study coordinator after the telemedicine visit until 50 had completed the surveys (December 2017).

As a reference group, we also invited in-clinic patients seen by these same providers to complete a survey. On clinical days selected based on the research coordinator's availability, all patients seen by these providers were consecutively approached by the coordinator, until 100 had completed the surveys (September 2017).

Data

Surveys were administered on the same day as the clinical visits via a secure, web-based research application (project-redcap.org), with paper surveys as an option if the patients preferred. A follow-up reminder was emailed to participants who had not responded within 1 week of the visit. If surveys were not completed within this time frame, participants were considered nonrespondents. Demographic and clinical details were obtained via medical record review, including clinical diagnosis and, for patients with MS, a neurologist-scored expanded disability status scale (EDSS) within the past year (details of a telemedicine-assessed EDSS are reported elsewhere[11]). To compare responses between in-clinic and telemedicine-based visits, *t* tests and χ^2 analyses were performed. Data were analyzed using SAS software program JMP, version 13 (Cary, NC).

Standard protocol approvals, registrations, and patient consents

The UCSF Committee of Human Research approved the study protocol (15–18,362), and all participants provided written informed consent completed electronically.

Data availability

An anonymized data set including data not published within the article will be shared on request from any qualified investigator.

Results

Demographic, clinical, and visit characteristics

The overall response rate was 61% (from 246 participants approached; no differences in age or sex between respondents and nonrespondents). The 50 participants seen in televideo were more likely than the 100 participants seen in the clinic to have completed college; there was also a trend for the televideo participants to be older, more often male, less likely to use televideo daily, and more likely than the patients seen in the clinic to have MS, whose diagnoses were more varied. Median EDSS for participants with clinically isolated syndrome (CIS)/MS in both groups was 3 (table 1). All study participants reported access to the internet in a convenient location (such as home). Telemedicine visits were shorter (mean [SD] minutes 29.7 [12.7] vs 53.7 [17.4], $p < 0.0001$]) and more often focused on specific topics (e.g., symptom management, results review, education, and counseling, $p < 0.0001$) than in-clinic visits; this was true when we compared telemedicine visits with in-clinic follow-up visits only (N = 68).

Table 1 Demographic, clinical, and visit characteristics across 100 in-clinic and 50 telemedicine-based visits

		In-clinic		*p* Value
	Telemedicine	**All**	**Follow-up only**	**Telemedicine vs all in-clinic**
Demographic characteristics	N = 50	N = 100	N = 68	
Patient age (y)	47.9 (12.0)	44.3 (11.9)	44.7 (12.3)	0.092
Sex (female)	32 (65%)	80 (80%)	53 (78%)	0.069
Education	N = 49	N = 99	N = 67	**0.013**
Did not complete college	8 (16%)	38 (38%)	29 (43%)	
Completed college	24 (49%)	29 (29%)	20 (30%)	
Some or completed advanced degree	17 (35%)	32 (32%)	18 (27%)	
Employment status	N = 49	N = 97	N = 67	0.091
Full time	20 (41%)	44 (45%)	30 (45%)	
Part time	3 (6%)	11 (11%)	8 (12%)	
Disability	9 (18%)	25 (26%)	20 (30%)	
Retired	10 (20%)	5 (5%)	3 (4%)	
Homemaker	3 (6%)	4 (4%)	3 (4%)	
Other (e.g., student, unemployed)	4 (8%)	8 (8%)	3 (4%)	
Internet use	N = 49	N = 99	N = 67	0.064
Daily	7 (14%)	21 (21%)	13 (19%)	
Weekly	11 (22%)	24 (24%)	17 (25%)	
Monthly	6 (12%)	5 (5%)	4 (6%)	
Occasionally	21 (43%)	30 (30%)	20 (30%)	
Rarely, never	4 (8%)	19 (19%)	13 (19%)	
Clinical characteristics				
Diagnosis	N = 50	N = 100	N = 68	0.16
MS/clinically isolated syndrome	49 (98%)	85 (85%)	55 (72%)	
Neuromyelitis optica spectrum disorder	0	3 (3%)	3 (4%)	
Neurosarcoidosis	0	2 (2%)	1 (1%)	
Other (see below)	0	6 (6%)	6 (9%)	
Uncertain	1 (2%)	4 (4%)	3 (4%)	
MS patients only: MS type	N = 49	N = 85	N = 55	0.081
Clinically isolated syndrome	0	6 (7%)	3 (5%)	
Relapsing-remitting MS	38 (78%)	62 (73%)	43 (78%)	
Progressive MS (primary + secondary)	11 (22%)	13 (15%)	8 (15%)	
Suspected MS	0	4 (5%)	1 (2%)	
EDSS (median [interquartile range, range])	3 (2.5–6.5, 1–8)	3 (2–4, 0–8.5)	2.5 (1.5–4, 0–8.5)	**0.003**
Visit characteristics				
Visit type	N = 48	N = 100	N = 68	0.22
Routinely scheduled	38 (79%)	88 (88%)	57 (84%)	
Semi-urgent	10 (21%)	12 (12%)	11 (16%)	

Continued

Table 1 Demographic, clinical, and visit characteristics across 100 in-clinic and 50 telemedicine-based visits *(continued)*

		In-clinic		*p* Value
	Telemedicine	All	Follow-up only	Telemedicine vs all in-clinic
Primary purpose	N = 48	N = 94	N = 62	**<0.0001**
Symptom management	18 (38%)	37 (39%)	37 (60%)	
Establish/transfer care	0	32 (34%)	0	
Medication adjustment, monitoring	5 (10%)	11 (12%)	11 (18%)	
New symptom	4 (8%)	7 (7%)	7 (11%)	
Results review	14 (29%)	3 (3%)	4 (6%)	
Education and counseling	7 (15%)	4 (4%)	3 (5%)	
Visit duration (min)	29.7 (12.7)	53.7 (17.4)	51.1 (17.1)	**<0.0001**

Abbreviations: EDSS = expanded disability status scale.
Other diagnoses: Chronic relapsing inflammatory optic neuropathy (CRION, n = 2); glutamic acid decarboxylase 65 (GAD65) autoimmune encephalitis; migraine; neuropsychiatric syndrome; and transverse myelitis not otherwise specified.
p Values <0.05 are in bold.

Features and outcomes of televideo visits

Televideo visits are usually scheduled for routine follow-ups after an annual in-clinic visit, at sooner time frames for ongoing symptomatic management, and more urgently for new symptoms or to review significant results. Patients mostly conducted televideo visits in their homes (79%) and at work (19%). They used laptops (51%), smartphones (33%), desktops (10%), and tablets (6%), which in all cases they currently owned or had access to. In 27% of the cases, a companion (typically their spouse or partner) was present with the patient. Occasionally, a partner or family member joined the televideo visit from a third location. During the encounters, the clinicians followed the usual clinical encounter format, initially eliciting the patients' objectives for the visit, then guiding the patient through subjective reporting and a review of symptoms. For the neurologic examination, instructions for positioning the patient are described elsewhere.[11] As many of the visits were focused on symptomatic management, results review, and pregnancy counseling, a full neurologic examination was not always required and was often limited to the relevant functional systems. Physicians reported an adequate physical examination for the purposes of the clinical encounter, in 48 (96%) visits (table 2). In the 2 exceptions when the televideo examination did not provide sufficient sensitivity (concern for cauda equina syndrome and visual field loss), a timely follow-up in-clinic evaluation was recommended. To review results, televideo software allows sharing of screens so that the clinician could display and highlight salient features of MRIs or laboratory results. Physicians reported that televideo visits avoided 3 patients being sent to the emergency department. Overall, physicians reported achieving their clinical goals in 49 (98%) of the televideo visits.

Patient satisfaction

Patients reported high satisfaction with their telemedicine care: 98% reported that the televideo technology was easy to use, and only 17% reported that an in-person examination would have been more effective in addressing their visit goals (72% "no," 11% "I am not sure"). When comparing patient satisfaction across in-clinic and telemedicine visits, satisfaction was globally high, with only minor differences noted (table 3). There was no association between a clinician's number of previous televideo visits and patient satisfaction with the visit. Across 8 domains of provider interpersonal communication skills, only 1 domain was significantly different (maintaining eye contact: 100% vs 96% visits where provider was rated as extremely/moderately good), but for the other 7 domains, satisfaction with in-clinic and telemedicine-based care was similar. Overall, 96% of in-clinic and 100% of telemedicine participants agreed/strongly agreed that their clinical goals had been met.

Table 2 Provider satisfaction with telemedicine visits

Response option	Responded "yes" (N = 48)
Remote examination was sufficient to address my patient's needs	46 (96%)
I was able to perform all of the testing and evaluation that I wanted to do today	47 (98%)
An urgent in-person follow-up was recommended sooner than routinely scheduled to address issues raised during the telemedicine visit	3 (6%)
Because I saw my patient via televideo today, I was able to avoid recommending certain unnecessary care details including (check all that apply)	
Trip(s) to the clinic	48 (100%)
Trip(s) to the emergency department	3 (6%)
Referral(s) ordered	4 (8%)
Test(s) ordered	3 (6%)

Table 3 Patient satisfaction with telemedicine and in-clinic visits

					In-clinic (N = 100)										***p* Value**	
	Telemedicine (N = 50)				**All (N = 100)**				**Follow-up only (N = 68)**						**Tele vs all in-clinic**	**Tele vs follow-up only**
I accomplished my goals at today's visit	N = 47				N = 94				N = 63						0.086	0.15
Strongly agree	40 (85%)				71 (76%)				48 (76%)							
Agree	7 (15%)				19 (20%)				12 (19%)							
Neither agree nor disagree	0 (0%)				4 (4%)				3 (5%)							
Disagree, strongly disagree	0 (0%)				0 (0%)				0 (0%)							
Satisfaction with visit	EG	MG	SG	MB	EG	MG	SG	MB	EG	MG	SG	MB				
	N = 47				N = 97				N = 65							
Giving you enough time	43 (91%)	4 (9%)	0 (0%)	0 (0%)	87 (90%)	8 (8%)	1 (1%)	1 (1%)	59 (91%)	5 (8%)	0 (0%)	1 (2%)			0.81	0.69
Asking about your symptoms	43 (91%)	4 (9%)	0 (0%)	0 (0%)	95 (98%)	1 (1%)	1 (1%)	0 (0%)	64 (98%)	1 (2%)	0 (0%)	0 (0%)			0.057	0.08
Reviewing and explaining tests results	42 (89%)	4 (9%)	1 (2%)	0 (0%)	92 (94%)	5 (5%)	0 (0%)	0 (0%)	64 (98%)	1 (2%)	0 (0%)	0 (0%)			0.61	0.09
Involving you in decisions about your care	46 (98%)	1 (2%)	0 (0%)	0 (0%)	94 (97%)	3 (3%)	0 (0%)	0 (0%)	64 (98%)	1 (2%)	0 (0%)	0 (0%)			0.74	0.81
Treating you with care and concern	46 (98%)	1 (2%)	0 (0%)	0 (0%)	97 (100%)	0 (0%)	0 (0%)	0 (0%)	65 (100%)	0 (0%)	0 (0%)	0 (0%)			0.15	0.24
Taking your problems seriously	46 (98%)	1 (2%)	0 (0%)	0 (0%)	97 (100%)	0 (0%)	0 (0%)	0 (0%)	65 (100%)	0 (0%)	0 (0%)	0 (0%)			0.15	0.24
Maintaining eye contact	40 (85%)	5 (11%)	1 (2%)	1 (2%)	96 (99%)	1 (1%)	0 (0%)	0 (0%)	65 (100%)	0 (0%)	0 (0%)	0 (0%)			**0.008**	**0.016**
Addressing physical symptoms	42 (89%)	1 (2%)	4 (9%)	0 (0%)	95 (98%)	2 (2%)	0 (0%)	0 (0%)	64 (98%)	1 (2%)	0 (0%)	0 (0%)			0.065	0.11

Abbreviations: EG = extremely good; MG = moderately good; SG = somewhat good; MB = moderately bad (not shown: somewhat bad or extremely bad).
p Values <0.05 are in bold.

Travel burden

Telemedicine visits offered a distinct advantage in reducing travel burden to the clinic (table 4). The in-clinic participants spent a mean (SD) of 7.3 (10) hours traveling from within and beyond California, with travel costs averaging 69.3 US dollars (SD 123.6, range 0–600), and mean roundtrip travel distance of 298 (SD 908) miles [480 km (SD 1,462)]. The patients seen via televideo, which was restricted to California residents only, reported avoiding an average travel distance of 160 (SD 196) miles [258 km (SD 316)]; 17% avoided overnight lodging, and

Table 4 Burden of travel to the clinic

	Telemedicine (N = 50)		In-clinic (N = 100)
Mean (SD) round trip travel distance from home to the MS clinic, in miles	160 (196)		298 (908)
Mean (SD) travel time to and from the visit, in h	7.8 (9.8)		7.3 (10.0)
Mean (SD) costs of travel (transportation, lodging, and parking), in US dollars			69.3 (123.6); N = 84
	Actual: "during today's televideo visit"	Hypothetical: "had you traveled to clinic today"	
Company at the time of the visit	N = 47	N = 47	N = 98
Alone	34 (72%)	24 (51%)	39 (40%)
Spouse/partner	10 (21%)	17 (36%)	36 (37%)
Parent	1 (2%)	0 (0%)	12 (12%)
Caregiver	1 (2%)	2 (4%)	4 (4%)
Child	1 (2%)	0 (0%)	2 (2%)
Friend	0 (0%)	2 (4%)	3 (3%)
Other	0 (0%)	2 (4%)	2 (2%)
Caregiver/spouse/partner take personal time off work or school (answering: "yes")		14 (30%)	29 (30%)
Need for personal time off work or school		N = 46	N = 94
Yes		15 (33%)	36 (38%)
Arrange care for a dependent		N = 47	N = 99
No or not applicable (no dependents)		32 (68%)	72 (73%)
Child		6 (13%)	25 (25%)
Spouse		0 (0%)	1 (1%)
Parent		0 (0%)	1 (1%)
Other		9 (19%)	1 (1%)
Need to stay overnight (answer yes)		N = 46	N = 97
Yes		8 (17%)	13 (13%)
Modes of transportation (number yes, can overlap)		N = 45	N = 95
Private car (someone else driving)		17 (38%)	42 (44%)
Private car (with me as driver)		25 (56%)	34 (36%)
Taxi or car service		3 (7%)	11 (12%)
Public transportation		3 (7%)	6 (6%)
Airplane		1 (2%)	2 (2%)
Paratransit		0 (0%)	1 (1%)

Comparison of actual travel burden for participants seen in the clinic to hypothetical travel burden for participants seen via telemedicine (limited to California).

1 avoided airfare. Caregiver burden was also reduced: 30% avoided caregiver time off from work, and 13% avoided arranging care for a dependent. Of the 46% of the patients who were employed, 65% avoided taking a day off from work.

Discussion

In this survey study, analyzing experience with clinic to in-home telemedicine in our academic MS and neuroimmunology clinic, travel and caregiver burden were reduced with the convenience of televideo-enabled visits while preserving efficient and effective care in the opinion of both patients and clinicians. These results support the integration of clinic to in-home telemedicine within the continuum of MS/neuroimmunology specialty care.

Overall, patient satisfaction with the neurologic encounter and perception of provider interpersonal skills were similar between telemedicine and in-clinic visits, with the overwhelming number of patients rating all components highly. These results are encouraging, given that many participants did not have considerable previous experience with technology and indicate that being technologically savvy is not necessarily needed to benefit from telemedicine-enabled care.

Patients also reported that substantial time and money were saved for themselves and their families and dependents. In a study of delivery of cognitive evaluations remotely for people with MS, it was estimated that $144 in travel costs and lost wages were saved relative to in-clinic evaluations.[12] Further studies are needed to expand on these cost analyses by more comprehensively quantifying the opportunity costs of in-clinic visits, such as "sick days" from work and childcare for children, as well as differences between in-clinic– and telemedicine-related billed health care costs or cost savings.

As might be expected, there were select clinical questions for which timely in-person visits were requested after the telemedicine encounter. There are also components of the neurologic examination that are less reliable or unable to be performed adequately using televideo[6,7,11] without a trained provider at the bedside (e.g., deep tendon reflexes) or specialized hardware (e.g., nonmydriatic fundus cameras). As a contingency, in our practice, providers and/or patients could and did request rapid in-person follow-up evaluation if outstanding questions remained after the televideo evaluation. Our results also demonstrate slight qualitative differences in patient assessment of the patient-doctor relationship between in-clinic and televideo clinical visits, particularly lower "eye contact" scores for televideo visits. Response bias could belie differences in patient satisfaction, although there were no clear differences in demographic characteristics between respondents and nonrespondents.

Given the generally high rates of patient satisfaction with the current encounters, it was not possible to probe whether specific aspects of MS-related disability affected the relative benefits and costs of televideo visits. For example, the televideo visit might slightly decrease the sensitivity of the examination to disease progression for a patient with severe ambulatory or cognitive impairment, but provide substantial convenience for a spouse experiencing a large caregiving burden, allowing them to maintain other competing needs (employment, home care, and self-care). For a patient with minimal functional impairment and intact cognition, the televideo visit might allow them to maintain high work productivity, but could limit the examiner's ability to detect subtle changes in vibratory function or muscle tone suggestive of disease progression. Therefore, the determination of the ideal scheduling and ratio of in-clinic to televideo visits will likely continue to be individualized.

More research will be needed to evaluate effects of clinic to in-home telemedicine on health care quality, outcomes, and cost metrics and to study a range of other potential telemedicine applications such as with interprofessional providers and to focus on symptom management and rehabilitation. It will be critical for insurers and policy makers to recognize the inherent value of telemedicine and develop more uniform approaches to reimbursement for telemedicine visits as part of the continuum of subspecialty outpatient care. As the field of neurologic telemedicine matures, it will also be important to develop best practices and to integrate telemedicine teaching into 21st century medical education. Our study supports the expansion of clinic to in-home telemedicine solutions for longitudinal outpatient care for neuroimmunologic conditions.

Author contributions

Study concept and design: R. Bove and J.M. Gelfand; Statistical analysis and interpretation of data: R. Bove; Acquisition of data and interpretation of results: P. Garcha, C.J. Bevan, E. Crabtree, R. Bove, and J.M. Gelfand; Manuscript drafting and revision: all authors.

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Disclosure

R. Bove served on the scientific advisory board of Roche-Genentech, Sanofi Genzyme, and Novartis; has a patent pending for selective estrogen receptor modulators and remyelination; and received research support from Akili Interactive, California initiative to advance precision medicine, the National MS Society, the Hilton Foundation, and the Sherak Foundation. P. Garcha reports no disclosures. C.J. Bevan reports no disclosures. E. Crabtree-Hartman received speaker honoraria from Biogen and Sanofi Genzyme;, consulted for Teva, Novartis, and Biogen; and served on the speaker's bureau for Teva and Biogen. A. Green served on the scientific advisory board of MedImmune, Novartis, Inception 5 Sciences, Pipeline, and Bionure; served on the editorial board of *JAMA Neurology*; served as an associate editor for *Neurology*; holds a patent for remyelination molecules and pathways; consulted for Inception 5 Sciences; received research support from Novartis, Inception Sciences SRA, NINDS, NIA, NIH, the National MS Society, the Sherak Foundation, and the Hilton Foundation; holds stock or stock options in Inception 5 Sciences, Pipeline, and Bionure; and served as an expert witness for Mylan Pharmaceuticals v Teva Pharmaceuticals. J. Gelfand is on the editorial board of *Neurology: Neuroimmunology & Neuroinflammation*; consulted for Biogen; received research support to UCSF from Genentech, MedDay, and Quest Diagnostics; received research support from the National MS Society; and received compensation for medical-legal consulting. Dr. Gelfand's spouse is an associate editor for *JAMA Neurology*; has received honoraria from UpToDate; and received consulting fees from Zosano, Eli Lilly, Biohaven, and eNeura. Full disclosure form information provided by the authors is available with the full text of this article at Neurology.org/NN.

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