Implementation and Patient Experience of Outpatient Teleneurology

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Abstract

Background: *Teleneurology has been well described for acute stroke, but outpatient use has been limited. At home, virtual visits have the potential to improve access to neurological care.*

Introduction: *This study reports on the use of a personal device videoconferencing platform for outpatient neurologic follow-up visits.*

Materials and Methods: *This is a cross-sectional study that identified all virtual neurologic follow-up visits completed by patients ≥18 years at a single institution over 4 years. Virtual visits were conducted by personal smartphone or computer via videoconferencing with a provider. Patients were asked to rate their overall experience with the visit and provider (five-point scale). Travel distance from the institution was calculated using patient's home addresses.*

Results: *Three thousand nine hundred thirteen patients completed 5,581 virtual visits during the study (mean age 49.4 ± 17.0 years, 58.7% female). Number of virtual visits increased from 30 in year 1 to 4,468 in year 4. Virtual visits were completed in all outpatient neurologic subspecialties. A total of 30.1% of patients were local (<50 miles), 25.9% were near regional (50–150 miles), 21.7% were far regional (151–270 miles), and 22.2% were remote (>270 miles). A distance of 1,327,128 miles of travel was prevented across the 5,581 visits. On average, patients rated their overall virtual visit experience 4.7/5 ± 0.89 and rated their provider 4.9/5 ± 0.48.*

Discussion: *Virtual visits prevented a substantial amount of travel and resulted in high patient satisfaction. The sizable proportion of local patients may indicate that teleneurology provides important access for reasons beyond travel distance.*

Conclusion: *This study demonstrates the feasibility of implementing outpatient teleneurology services.*

Keywords: *teleneurology, virtual visits, patient experience, access to care, telemedicine*

Introduction

Neurologic diseases are the leading cause of disability and the second leading cause of death worldwide.[1] The annual cost to the American society for just nine common neurologic diseases was estimated to be $789 billion in 2014.[2] Although there is an increasing prevalence of neurological diseases, there is a shortage of neurologists to treat these conditions.[1–3] In 2012, there was a 11% shortage of neurologists nationwide, which is projected to grow to 19% by 2025.[3] This shortage is going to worsen the long wait times to see neurologists for both new patient visits (34.8 business days) and follow-up visits (30.0 days).[3] The care shortage is compounded by the fact that travel, even locally, can be difficult for neurological patients who may be burdened by disability, fatigue, driving restrictions, and financial limitations. Insufficient access to neurological care is a substantial problem. Thus, more efficient ways to deliver care are urgently needed.

Teleneurology has the potential to aid in addressing the substantial need for improved access to neurological care. Telemedicine has been more widely adopted for the delivery of outpatient primary care, and several large reports indicate many potential advantages to providing virtual care. The Ontario Telemedicine Network reported facilitating 204,058 patient consultations in a year, saving an estimated 130 million miles of travel. Overall, 92% of patients surveyed were satisfied with the telemedicine visit and 74% reported saving money. This network also reported reductions in hospitalization rates for patients enrolled in telehealth programs for congestive heart failure, pulmonary disease, and mental health crisis.[4] Teladoc, a U.S.-based telehealth company, assessed 3,701 telemedicine visits and found that their users were less likely to have used health care before the introduction of the telemedicine services and 34% of visits were conducted on weekends and holidays, suggesting that telemedicine had expanded access and made care more convenient.[5] An insurance company study assessing episode-level utilization of virtual visits for acute, nonurgent care found that virtual visits cost on average $162 less than a traditional primary care visit.[6] Finally, another telemedicine study found

that of 81,549 primary care visits conducted, 70% were able to be done with a patient's established provider, suggesting that telehealth could be used to maintain continuity of care.[7] However, in all of these large telemedicine studies, neurology was not among the top visit categories.[4,5,7]

Telestroke was initially implemented in 1999 and now after 20 years is a standard part of providing acute neurological care.[8] Before telestroke, many patients with acute stroke symptoms were not evaluated by a neurologist and <1.5% of acute strokes were treated with thrombolytics.[8] Stroke neurology has made many changes to increase patient access to acute neurologic care and a substantial number of eligible patients now receive IV tPA.[9] Telestroke has played an integral part in improving access and is an excellent model for how technology can improve patient care.

Yet, outpatient teleneurology has not been widely used. In a 2010 survey, only 7 of the 30 leading U.S. neurology departments were using teleneurology to provide any chronic care.[10] Research in teleneurology has also been limited, with only nine randomized control trials (RCTs) since 1992 that have included more than 100 patients.[11] Of these studies, only three were carried out with a neurologist as a provider, and only one of those studies was done with the patient being located at home.[11–14] Beyond RCTs, other large teleneurology studies have been limited in size and performed via suboptimal platforms. One study that assessed teleneurology to deliver care to rural-based patients included 1,100 patients who were still required to travel to community clinics to videolink with a neurologist.[15] Another study that reported on teleneurology use within the Los Angeles Veterans Affairs system included 570 patients and again required patients to travel to their local VA clinics to videolink to the neurologist.[16] These studies have shown that patients were satisfied with teleneurology visits, patients kept their appointments, and teleneurology filled a gap in available care.[16,17] However, for teleneurology to optimally expand access, it should be done on a platform that can be utilized from any internet-connected location and integrated on a larger scale as an alternative to traditional in-office visits.

This study details a large-scale implementation of a personal-use videoconferencing platform for subspecialty outpatient neurologic follow-up.

Materials and Methods

PATIENT POPULATION

All patients were at least 18 years old and had access to a device with internet connectivity as well as videoconferencing capability. All patients had previously been seen in-person by a neurology, neurosurgery, or psychiatry provider within the institution. Patients voluntarily selected a virtual visit instead of a traditional in-person office visit. Data were collected as part of routine clinical care from the beginning of virtual visit implementation in October 2014 through September 2018.

STANDARD PROTOCOL APPROVALS, REGISTRATIONS, AND PATIENT CONSENTS

This study was approved by the Cleveland Clinic Institutional Review Board.

VIRTUAL VISITS

Patients were scheduled for virtual follow-up visits within the time frame agreed upon by the patient and provider. The patient then received an e-mail with instructions on how to access and use the virtual visit platform as well as information on continuously available technical support. At the time of the visit, the patient used a personal device to log into the virtual platform. The patient could invite a remote family member to join the visit. The providers similarly accessed the virtual visit platform at the scheduled time, typically from their office via webcam although visits could also be conducted via a provider's smartphone. Once all parties had joined, they were connected in live videoconferencing and the visit was conducted. The platform was encrypted, HIPPA compliant, and integrated into the electronic medical record (EMR), including scheduling, documentation, and billing services. The provider had access to the patient's EMR during the visit and documented and performed billing within the EMR. The platform used was Cleveland Clinic Express Case Online® supported by American Well. If a medical emergency occurred during the encounter, providers were instructed to reach out to local 911 by phone while remaining connected to the patient via the virtual visit until medical emergency services arrived. The providers who conducted the visits included physicians, advanced practice clinicians, and psychologists. State licensing was properly addressed by all providers wherever required.

Immediately following the visit within the platform, an optional survey appeared to all patients that asked "How was your visit?" Within the survey box appeared "Rate your provider" with five blank stars that the patient could click to indicate her/his rating and "Rate your overall experience" with again five blank stars that the patient could click to indicate her/his rating. No opportunity was given to complete the survey at a later time.

STATISTICAL ANALYSIS

The main objectives were to assess utilization, demographics of users, patient experience, and travel distance prevented with virtual visits. For utilization, the number of virtual visits per year was assessed as well as distribution of visits across the subspecialties. Subspecialty categorization was decided based

on the provider's subspecialty. Likert scale survey response ratings of provider and visit experience were used to evaluate patient perceptions. Travel distance prevented was calculated using a SAS macro that utilizes Google Maps to determine driving distance. Visits from locations not reachable via driving had air distance calculated.[18] In addition, to evaluate local versus remote patient utilization of virtual visits, participants were grouped into four discrete distance categories relative to the institution: local (<50 miles), near regional (51–150 miles), far regional (151–270 miles), and remote (>270 miles). These categories were created according to the geography surrounding the institution. The local category includes Greater Cleveland and out to the nearby city of Akron. The near regional category extends the distance to the next large cities, which are Pittsburg, Columbus, and Toledo. The far regional category extends to include the travel distance from across the state to the institution. The remote category is all regions that fall beyond the travel distance across the state to the institution. Analyses were performed using SAS software (version 9.4; Cary, NC).

DATA AVAILABILITY

Anonymized data will be shared with qualified investigators by request from the corresponding author for purposes of replicating procedures and results.

Results

Patient and virtual visit encounter characteristics are presented in *Table 1*. There were 5,581 completed encounters by 3,913 patients over the 4-year period from October 2014 through September 2018. Patients ranged in age from 18 to 92 years and a quarter of patients completed more than one virtual visit. The average visit duration was 19.7 min.

The frequency of encounters by subspecialty is presented in *Table 2*. Headache providers completed the most encounters (21.7%) followed by epilepsy (19.3%) and spine (15.9%). Utilization of virtual visits increased from 30 visits in year 1 to 4,468 visits in year 4 (*Fig. 1A*). All subspecialty utilization increased over the 4 years (*Fig. 1B*). Headache, epilepsy, and spine tripled the number of encounters between years 3 and 4. Movement disorders doubled the number of encounters between years 3 and 4, and steady growth was seen in all other subspecialties. The no show rate over the 4 years for the subspecialties with the highest frequency of encounters was 13.3% (headache), 11.2% (epilepsy), and 8.9% (spine). The number of providers who completed virtual visits steadily increased from 1 in year 1, 42 in year 2, 97 in year 3, and 186 in year 4.

Table 1. Virtual Visit and Patient Characteristics

CHARACTERISTIC	STATISTIC
Total no. of virtual visits, *n*	5,581
Total no. of unique patients, *n*	3,913
No. of patients with a repeat virtual visit, *n* (%)	982 (25.1)
Age, mean ± SD	49.4 ± 17.0
Sex, *n* (%) female	2,295 (58.7)
Visit duration, min ± SD	19.7 ± 13.0
Patient distance categories, *n* (%)	
Local patients <50 miles	1,179 (30.1)
Near regional patients 51–150 miles	1,013 (25.9)
Far regional patients 151–270 miles	851 (21.7)
Remote patients >270 miles	870 (22.2)
Travel distance prevented, miles (median [IQR])	125.0 [35.5, 256.0]

IQR, interquartile range.

Table 2. Number of Virtual Visits Completed by Neurological Subspecialties

SUBSPECIALTY	NO. OF VIRTUAL VISITS, *N* (%)	TRAVEL PREVENTED, MEDIAN [IQR]
Headache	1,211 (21.7)	91 [26, 210]
Epilepsy	1,079 (19.3)	124 [45, 252]
Spine	887 (15.9)	142 [54, 265]
Movement	610 (10.9)	191 [71, 287]
Psychiatry/psychology	361 (6.5	30 [17, 81]
Autonomic	322 (5.8)	267 [167, 389]
Cerebrovascular	271 (4.9)	130 [24, 268]
Neuro-oncology	194 (3.5)	140 [78, 237]
Neuroimmunlogy/multiple sclerosis	142 (2.5)	220 [121, 315]
Cognitive	141 (2.5)	197 [24, 465]
Sleep	135 (2.4)	69 [21, 300]
Vestibular	86 (1.5)	157 [41, 270]
Pain	84 (1.5)	212 [84, 301]
Pediatric neurology	15 (<1)	335 [200, 1,062]
Pediatric neurosurgery	14 (<1)	93 [14, 150]
Adult neurosurgery	11 (<1)	374 [298, 622]
Neuromuscular	9 (<1)	264 [183, 346]
Physical medicine and rehabilitation	9 (<1)	81 [77, 81]

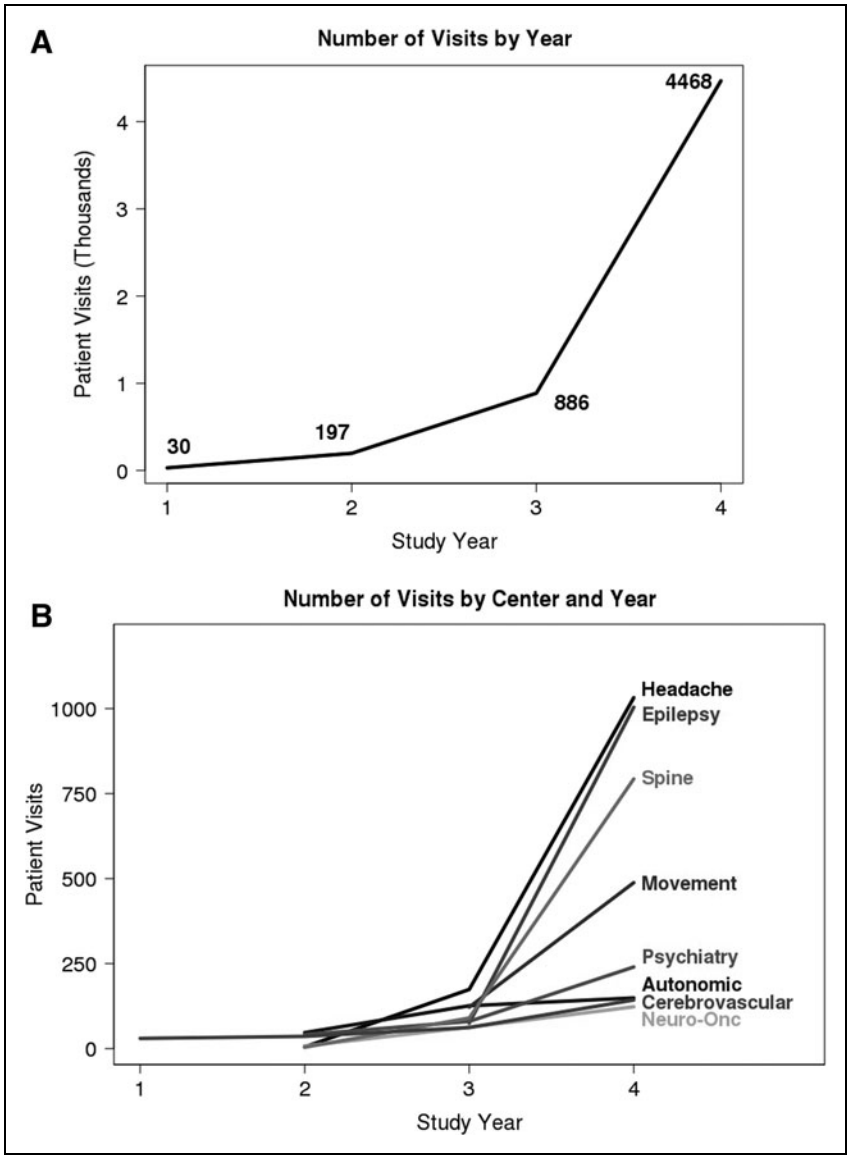

Fig. 1. Total utilization **(A)** and utilization by subspecialty **(B).**

Encounters were conducted by patients from 47 states, including Alaska and Hawaii (*Fig. 2*). A total of 30.1% of patients were local, 25.9% were near regional, 21.7% were far regional, and 22.2% were remote. Patients with more than one encounter had a similar distribution (*Fig. 2*). Of the 3,192 encounters completed in Ohio, 25.2% were completed in the Cuyahoga County where the Cleveland Clinic is located (*Fig. 3*). In the state of Ohio, an encounter was completed from all but two counties. A total of 1,327,128 miles of travel were prevented if the patients had to travel from their home address to the institution. A median of 137 miles of travel was prevented per encounter. The median travel distance saved varied by subspecialty, with autonomic disorders having the highest median miles prevented (267 miles) (*Table 2*).

There was a 58% response rate to the postvisit survey. The mean patient rating of online care was 4.7/5 and mean rating of online provider was 4.9/5. Eighty-five percentage of respondents gave a top rating of 5/5 for online care and 94% gave a top rating for their provider.

Discussion

This study demonstrated that outpatient follow-up teleneurology is feasible for many neurologic subspecialities. Patients represented a wide range of ages and locations across the United States. The number of encounters increased 149-fold from year 1 to 4. The growing utilization of outpatient teleneurology seen both overall and within subspecialty care over the 4 years may indicate an increasing patient and provider demand for this modality of care. In addition, 25% of patients completed more than one virtual visit during the study period, which further supports patient satisfaction and desire for this method of care delivery. Overall, patients reported very high ratings for both the online care and provider supporting patient satisfaction.

To our knowledge, this is the largest reported experience with teleneurology and the only study with a wide range of subspecialty providers. The wide range of patients served by all neurologic subspecialties demonstrates the broad applicability of teleneurology for the delivery of outpatient neurological care. The largest previous reported outpatient study included 1,100 patient visits and it utilized a platform that still required patients to travel to a clinic to conduct the visit.[15] In our study population, the subspecialties with the highest number of encounters were headache, epilepsy, spine, and movement disorders. It is possible that this pattern reflects that some subspecialty practices may be better suited for virtual care than others. At our institution, these are also the largest subspecialty divisions, such that staffing levels and disease prevalence also likely contributed to the higher number of encounters in these disciplines.

Patients were served from across the United States. Although this service provided access for individuals living a considerable distance from our institution, we observed that a large proportion (30%) of patients were local. This result

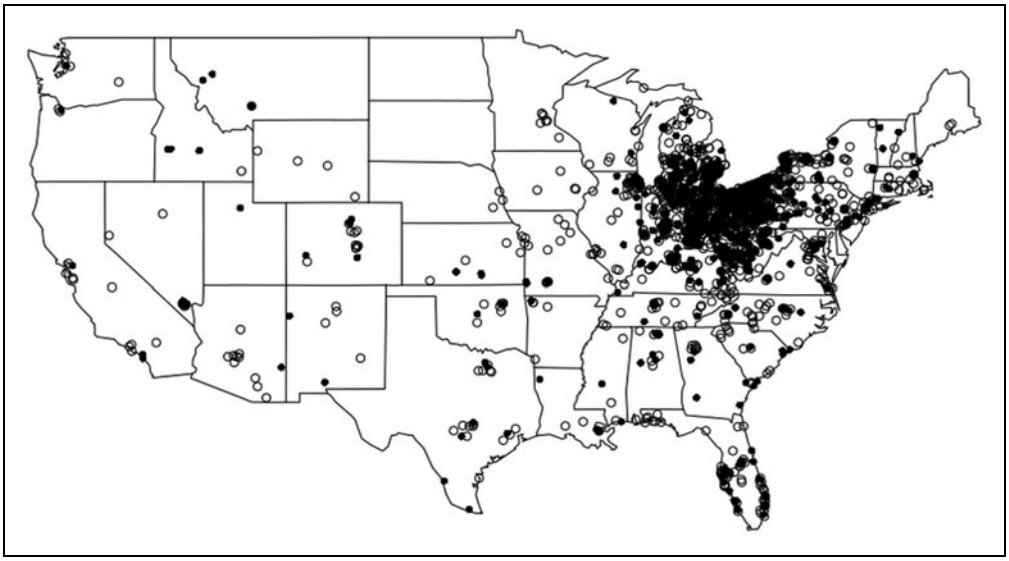

Fig. 2. Location of patients completing virtual visits. Open circle = single visit, closed circle = repeat visit.

indicates that teleneurology services are not just providing increased access to traditionally underserved areas or providing access to patients at a distance. The large number of local patients utilizing virtual care indicates that patients benefit from this modality of care for a variety of reasons. This study did not specifically ask why patients chose virtual visits. Future studies should focus on the ability of teleneurology to provide better access to neurological services by closing the gap in care created by costly travel to providers, patient's level of disability, and limited number of specialists. Our study's high proportion of local patients is an indicator that teleneurology is providing important access to patients for reasons other than distance. Finally, the higher proportion of local patients also suggests that teleneurology may be useful outside of an academic tertiary care center, but further studies reporting utilization in different health care settings are needed.

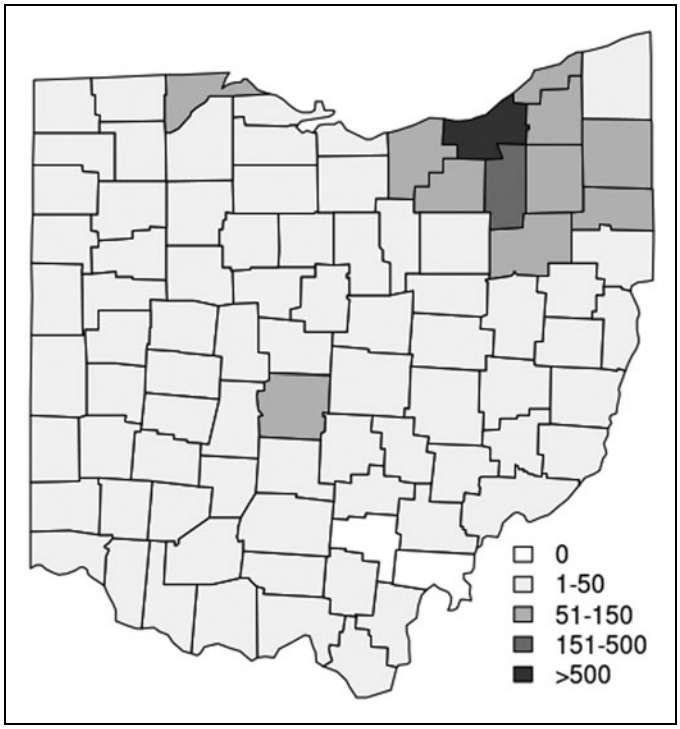

Fig. 3. Density plot of virtual visits completed in the state of Ohio, by county.

In the field of neurology, there continues to be an increasing gap between the demand for neurological care and the number of providers.[3] The shortage of neurologists is an urgent need and teleneurology has the potential to provide increased access for patients. In the current age of rapid technological advancement, we have an ever-growing number of tools at our disposal. We need to continue to find ways to leverage technology to improve our care delivery to facilitate effectively providing neurological care to more people. As teleneurology is integrated into clinical practice, the lack of a traditional neurological examination is a limitation with a variety of potential solutions. This mode of care delivery has the opportunity to give providers unique information about patients' ability to function in their homes. Subspecialties could develop video-based examinations that capitalize on the home environment to better understand aspects of gait, balance, and motor function. In addition, self-administered digital neuroperformance testing and patient-reported outcomes relevant to disease states could be performed before or during the visit to supply objective data for these visits. Finally, teleneurology and traditional office-based visits could be alternated to provide intermittent traditional examination information for monitoring of important disease outcomes. Future studies should be performed to better understand the value and validity of remote neurological assessments to augment teleneurology visits.

We acknowledge that this study has several limitations, including it was a single academic center and a largely descriptive study. Although it was performed at a single center, the large scale and breath of subspecialty care provided are

important initial steps to demonstrating both the feasibility and applicability for a wide range of neurological care needs. In addition, all the patients who performed the virtual visits were self-selected and the responses to the survey were optional. These aspects introduce selection bias for individuals who desired to receive care virtually. There are several randomized-controlled trials evaluating teleneurology in an outpatient setting for chronic neurological conditions, most are small (<50 patients), have minimal long-term data, are done on an inconvenience platform (e.g., requiring travel to a local clinic to connect), or have not had a neurologist as the clinician.[12–14] In addition, most of these studies have only been powered to demonstrate feasibility. Future randomized-controlled studies are needed to assess the quality of care and patient satisfaction of virtual care compared with traditional in-person visits. As with any technology, technical issues can arise that impede the implantation and utilization. Although this study did not focus on these, technical limitations overall are limited. Most of the issues encountered are secondary to a low bandwidth from the patient's connection. The most common issue was the utilization of public WiFi leading to a slower bandwidth. It would be useful in future studies to formally log all technical limitations to aid with the development of teleneurology services as demand increases. Finally, this study was not designed to assess clinical outcomes or economic impact for patients and the health care system. Larger studies within individual disease states are needed to assess the impact of virtual care on disease-specific outcomes along with the impact on health care costs at the level of patients, institutions, and the health care system.

Conclusions

Teleneurology can be utilized to deliver a wide range of subspecialty neurological care. We found that patient satisfaction was overall high and there is an increasing demand for this service. This study also demonstrated that patients chose to utilize this mode of health care at a wide range of distances from our institution, suggesting that teleneurology provides benefits beyond simply improving access to care for remote or underserved areas. Future studies are needed to determine the impact of teleneurology care on health outcomes and the economic impact to patients and the health care system.

Disclosure Statement

L.R., J.B., L.M., H.G., and N.C. have nothing to disclose. R.B. has served as a consultant for Biogen, Genzyme, Genentech, and Novartis and receives research support from Biogen, Genentech, and Novartis. Z.A. has a research grant from Teva and serves as a consultant for Lilly and Amgen and serves on the Supernus advisory board. J.K. has unrestricted education grants from Allergan and Amgen and has performed consulting, writing, and editing work for DynaMed Plus. E.E. serves as a faculty adviser to Lilly and is part of the speaker's bureau for Teva. P.R. serves on the medical advisory board for Teladoc and American Well. H.H.F. has received research support from Acorda Therapeutics, Michael J. Fox Foundation, Movement Disorders Society, NIH/NINDS, Parkinson Study Group, and Sunovion. He receives honoraria from the American Osteopathic Association, Cleveland Clinic, South Alabama Medical Science Foundation, Thoraxx Clinical Communications, UMA Education as a speaker for CME events. He receives honoraria from Acorda Therapeutics, Denali Therapeutics, Pfizer, Partners Health Care System, Sunovion Research and Development Trust as a consultant and from Elsevier as an editor. He receives royalty payments from Demos Publishing and Springer for authorship and editing. He has contractual services with Teva for research and serves as a publication committee member for Acorda Pharmaceuticals and Sunovion Pharmaceuticals. I.N. has served on the scientific advisory board and is part of the speaker's bureau for Eisai. M.M. has served on scientific advisory boards for Genzyme and Genentech.

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