Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Parkinsonism and Related Disorders 98 (2022) 56–61

Contents lists available at ScienceDirect

Parkinsonism and Related Disorders

journal homepage: www.elsevier.com/locate/parkreldis

Success of home-to-home tele-neuropsychology (TeleNP) in deep brain stimulation (DBS) candidacy assessments: COVID-19 and beyond

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1. Introduction

COVID-19 was declared a global pandemic on March 11, 2020, leading to significant challenges in the delivery of healthcare. Many clinics closed abruptly for the safety of providers and patients, and practitioners had to adapt to new remote models of assessment to reduce exposure risks. Mandatory stay-at-home orders as well as mandates by some institutions to cease all non-emergency practice impacted the ability to conduct neuropsychological assessments face-to-face. This created an immediate need to develop telehealth services for vulnerable populations, including movement disorder patients who were already deemed high risk due to medical comorbidities [1]. Specifically, the assessment and management of individuals with movement disorders, especially with regard to the evaluation of deep brain stimulation (DBS) for surgical candidacy posed unique challenges.

Clinical neuropsychologists work in conjunction with a multidisciplinary team that includes neurosurgeons, neurologists, psychiatrists, social workers, and physical therapists [2]. For neuropsychologists, pre-operative neuropsychological DBS assessments primarily focus on identifying relevant neurocognitive and behavioral factors, assessing level of family support, and delineating goals and expectations for DBS [3]. Patients with movement disorders, in particular Parkinson's disease (PD), may have impairments in verbal fluency, processing speed, attention, executive function and visuospatial skills which affect their ability to complete daily tasks [2]. Those with visuospatial impairments typically represent a more cognitively impaired group and may fare worse following DBS [2]. Therefore, thorough assessment of cognition is critical as consistent improvement in quality of life and motor function has been found following DBS for PD patients [4].

A survey conducted by the Functional Neurosurgical Working Group (FNSWG) of the Parkinson Study Group (PSG), indicated that the pandemic led to the closure of clinical pre-DBS evaluations in 96% of programs, with 70% halting pre-operative neuropsychological evaluations and 57% reporting no tele-neuropsychology or in-person visits were possible [5].

The dramatic shift away from outpatient face-to-face visits prompted further exploration of using telemedicine to offer continued care. Further, the arrival of new variants such as Omicron reinforce the concept that telemedicine will become an increasingly desirable option for those unwilling or unable to travel. This is also supported by a precedent for using remote telemedicine as an adjunct service in the past, where it has been used to complement in-person visits [6]. Particularly, PD patients endorse high rates of satisfaction with telemedicine [6]. Telemedicine allows for continued care and interventions (exercise, therapy, cognitive training) within the PD patient's home, even for patients with more severe symptoms, preventing unnecessary travel to the hospital [7].

Telemedicine has also been shown to be useful when adjusting DBS settings [8], though data is more limited on how to utilize this modality to properly assess DBS candidacy. One study found that video telemedicine can be used to facilitate presurgical screening for DBS in patients with dystonia, essential tremor, and PD, and saves costs in travel time and expenses [9]. However, this study assessed neurological screening, not neuropsychological assessment.

This encouraged our group at the University of Miami (UM) to develop comprehensive remote pre-surgical neuropsychological evaluations using home-to-home Teleneuropsychology (TeleNP). To our knowledge, there is no consensus to date regarding TeleNP to assess pre-DBS candidacy nor are there metrics for examining whether this strategy can be successfully employed as a screening tool. This manuscript reviews the implementation and feasibility of home-to-home TeleNP DBS evaluations. Given our sample of multicultural patients, we also evaluated the utility of employing TeleNP with a diverse sample. At this time, we believe we are one of the few programs in the nation offering comprehensive and bilingual remote pre-DBS neuropsychological assessment.

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https://doi.org/10.1016/j.parkreldis.2022.04.009
Received 28 December 2021; Received in revised form 7 April 2022; Accepted 17 April 2022
Available online 22 April 2022

2. Preparation of the neuropsychology virtual platform: developing guidelines for TeleNP during the start of the pandemic

The Division of Neuropsychology and Cognitive Neuroscience at UM Miller School of Medicine closed its outpatient clinic on March 16, 2020 due to COVID-19. As with clinics across the globe, we were challenged by the abrupt halt of face-to-face assessments, and we developed and implemented a TeleNP platform in both English and Spanish. We embarked on a thorough multistep framework to ensure continuity of care for all patients referred from the Department of Neurology, including all of our pre-surgical DBS cases.

The first step in our transition included participation of all providers in webinars led by pioneers in the field of neuropsychology [10,11] as well as review of available literature [12]. This led us to review the recommendations from professional organizations such as the American Psychological Association (APA), the International Neuropsychological Society, the Inter Organizational Practice Committee, and the National Academy of Neuropsychology. Specific recommendations including competence, licensure issues, reimbursement, informed consent, telecommunication platforms, and technical specifications, as discussed by Bilder and colleagues [12], paralleled to ethical guidelines, informed our decisions, and allowed us to efficiently establish the foundation of a successful TeleNP program.

Given the rapidly evolving changes in mandated prevention, we continued to incorporate emerging recommendations to maintain our clinical practice during the pandemic [13]. We considered multiple models of care: modified in-person administration (using mitigation procedures), in-clinic TeleNP, in-home TeleNP, combined/hybrid model, or delaying care [14]. We also reviewed the protocols of other programs in the country that developed a model to assess DBS candidacy via telehealth [15]. As stay-at-home orders were still in full effect, we concluded that in-home TeleNP (home-to-home) was the most viable strategy for continuity of care. Although research on in-home TeleNP is scarce [13], feasibility and acceptance of direct-to-home-teleneuropsychology from both patients and providers have been reported [16].

We created a protocol to continue clinical services remotely. We then adapted our consent form, created interview forms, carefully reviewed and selected available tests (considering test administration and copyright laws), and developed digital record forms. We selected Zoom Video Communication, the encrypted HIPAA-compliant platform, to complete synchronous video and call visits. We were able to establish all layers of neuropsychological assessment including record review, clinical interviews with patients and collateral informants, emotional status screening, cognitive testing, and interventions such as psychoeducation and feedback [17].

Four formal standard operating procedures (SOPs) were created to ensure patient, provider, and staff safety: Telehealth Graduate Students and Postdoctoral Fellows, Suicidal Ideation Reports in TeleNP, Domestic Violence Reports in Virtual Neuropsychology and Therapy Services, and Staff During Telehealth. Our division held weekly 2-hour trainings to review the SOPs with all team members to ensure their understanding prior to beginning scheduling for telehealth.

Researchers have documented the complexities to pre-DBS neuropsychological assessments during the pandemic [18,19]. The work of the Neuropsychology Focus Group from the FNSWG of the PSG has been critical in the identification of the different models of care and supportive research on the validity of TeleNP in pre-DBS evaluations as well as recommendations for neuropsychological measures to be used for pre-DBS screening via telehealth [19]. Potential benefits of in-home TeleNP include avoiding long commutes, decreasing fall risk, reducing fatigue, decreasing anxiety, minimizing exposure risks, and avoiding wearing a mask in already hypophonic individuals, among others [18].

3. Implementation: home-to-home TeleNP at the University of Miami

3.1. Methods

Participant selection. From May 2020 to September 2021, we received 540 patient referrals for a neuropsychological evaluation. Ninety-eight were movement disorder patients referred for a DBS pre-surgical work-up (Fig. 1). Twenty-five met exclusion criteria of prior DBS surgery or comorbid movement disorders (17 post-DBS, six comorbid essential tremor, two dystonia). The remaining 73 cases met diagnostic criteria for idiopathic PD (based on UK PD Brain Bank Criteria [20]) without comorbid movement or neurodegenerative disorders and completed a comprehensive pre-surgical evaluation, including neurological exam (by a movement disorder specialist), clinical interview, and testing (by a neuropsychologist and postdoctoral fellow).

Participant flow. Staff screened each patient by phone to verify testing location (must be within the state), access to appropriate resources (desktop, laptop, or large tablet with broadband private internet availability), comfort with telehealth technology, and a distraction-free environment. Collateral reporting was allowed during interview with patient consent. Staff provided pre-appointment technical assistance, if requested. Patients digitally signed a general and TeleNP-specific consent form. Screened patients were then scheduled for two home-to-home TeleNP appointments: First, a comprehensive clinical interview and assessment of emotional functioning (1.5–2.5 h); second, the cognitive testing session (scheduled separately to reduce fatigue; 2.5–3.5 h). There was one 5–10 min break at appointment one and a minimum of two breaks for appointment two; additional breaks were available upon request. Electronic testing materials and data were stored on a HIPPA compliant server using two-factor authentication. See Fig. 1 for a process summary.

Measures. The neuropsychological battery was comprised of tests known to be clinically sensitive to cognition in PD, with established reliability and validity [21,22]. These tests minimize motor demands, are commonly administered in other national DBS centers [2], and have been recommended for telehealth in DBS [18]. Verbal tests administered via telehealth did not compromise standard administration. For visual tests, the administrator used the "Share Screen" feature to present test stimulus materials to the patient [12,15,19]. The battery included a general screen (Montreal Cognitive Assessment), and measures of attention (Digit Span), word retrieval (Boston Naming Test), verbal fluency (Controlled Oral Word-Association Test), visuospatial skills (Matrix Reasoning), verbal learning and memory (California Verbal Learning Test- Third Edition, Logical Memory Scale), and executive functioning (Similarities, Oral Trails B). Mood questionnaires included the Beck Depression Inventory-Second Edition and Beck Anxiety Inventory.

4. Feasibility: meeting the needs of our patients

Presurgical review of results. Completed presurgical assessments were then reviewed in regularly scheduled DBS multidisciplinary meetings (including neurosurgery, neurology, neuropsychology, psychiatry) to determine surgical candidacy. Patients were considered to be good candidates for DBS if there was troublesome on/off fluctuation, dyskinesia, or medication-refractory tremor, if an adequate response to levodopa was established (greater than 30% improvement from off to on-med on the Movement Disorder Society-Unified Parkinson's Disease Rating Scale; MDS-UPDRS), and surgery was not contraindicated (i.e., psychosis, suicidality, dementia, lack of support, unrealistic outcome goals, diagnostic uncertainty) [2,4]. Eighty-eight percent (64) of the assessed candidates were approved for DBS.

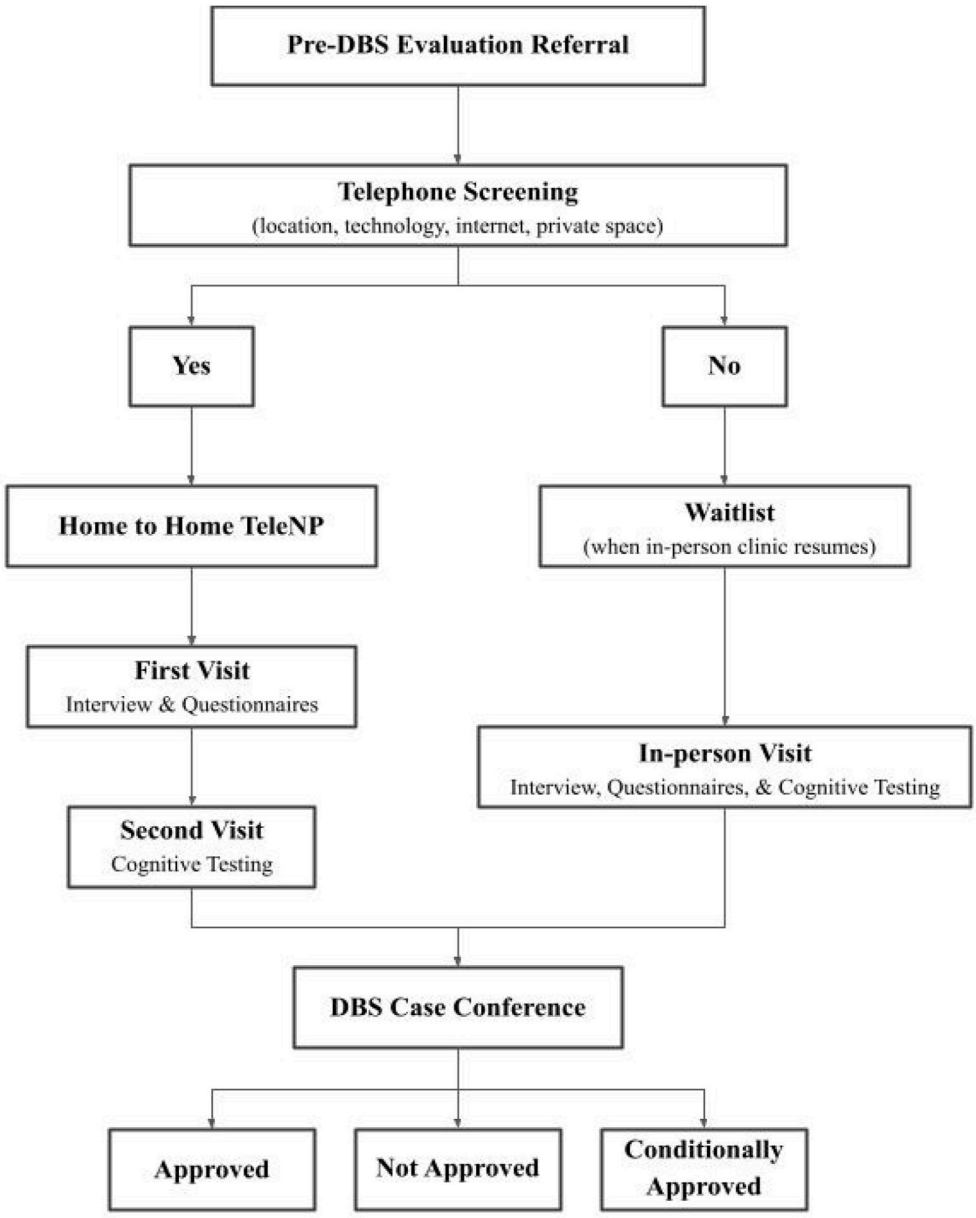

Fig. 1. Summary of home-to-home TeleNP patient selection and scheduling.

Table 1
Demographics and clinical information compared by group (from patient data collected from May 2020 to September 2021).

	Eval (n = 73)	Appr (*n* = 64)	Comp (*n* = 44)	Sched (n = 11)	Decl (*n* = 9)	NApp (*n* = 7)	Cond (*n* = 2)	*p*: Appr vs. NApp[a]
Demographics								
Age (yr)	63.3 (8.75)	62.5 (8.58)	62.1 (8.44)	62.9 (6.96)	64.0 (11.5)	69.4 (8.18)	66.0 (12.7)	.048
Education (yr)	14.4 (3.12)	14.8 (2.94)	14.7 (3.09)	15.4 (2.98)	14.9 (2.32)	10.6 (2.37)	14.0 (2.83)	.001 (*d* = 1.19)
Gender (% Male)	65.8	67.2	65.9	72.7	66.7	57.1	50.0	
Ethnic (% Hispanic)	49.3	46.9	50.0	45.4	33.3	85.7	0	
Clinical Information								
Testing (English/Spanish)	43/30	40/24	26/18	6/5	8/1	1/6	2/0	
Disease duration (yr)	11.3 (6.85)	11.7 (7.08)	11.7 (5.55)	9.55 (3.01)	14.1 (14.3)	7.86 (2.54)	12.5 (9.19)	.259
Age of onset	52.0 (10.9)	50.9 (10.5)	50.4 (9.88)	53.4 (7.24)	49.9 (16.6)	61.6 (6.95)	53.5 (21.9)	.020
Pre-DBS UPDRS On Medication	17.3 (11.9)	15.4 (10.3)	12.8 (8.18)	21.8 (12.4)	22.6 (12.9)	33.0 (15.3)	31.0 (9.9)	.001 (*d* = 1.61)
Pre-DBS UPDRS Off Medication	49.2 (12.0)	48.0 (11.4)	47.2 (10.1)	52.1 (15.8)	46.5 (11.2)	57.8 (15.3)	58.5 (14.8)	.027
UPDRS % Improved	66.7 (18.0)	69.5 (17.0)	73.5 (14.8)	57.6 (20.1)	60.2 (16.5)	45.4 (8.49)	47.5 (3.59)	.001 (*d* = 1.48)

Note. Eval = evaluated for surgery group; Appr = approved for surgery group; Comp = completed surgery group; Decl = patient declined surgery group; NApp = not approved for surgery group; Cond = conditionally approved for surgery group; UPDRS = Unified Parkinson's Disease Rating Scale (Part III). [a] Significant differences denoted in bold type per Student's *t* with $p < .003$ (Bonferroni adjusted).

4.1. Results

Participant demographics. Table 1 illustrates demographic information, testing language, disease duration, age of onset, and pre-DBS on/off UPDRS Part III scores, for the sample. On average, the sample was 65.8% male, age 63.3 years, with two years of college education, and 49.3% Hispanic. Average age of onset of PD was 52, with PD disease duration of 11.3 years. Pre-DBS UPDRS mean scores of the entire sample off medication was 49.2, improving to 17.3 on medication.

Group comparisons. Of the 64 approved patients, 44 completed DBS at the time of manuscript (60% of the initial sample). An additional 11 remain scheduled for DBS, while another nine approved decided against surgery (one due to insurance limitations; one due to cardiology risk; seven for unspecified reasons). Of the 73 patients, seven were not approved for DBS; three had major neurocognitive disorder (NCD); two showed psychosis; and two demonstrated NCD in the context of a family history of multiple systems atrophy and were referred for genetic testing. Two other candidates were conditionally approved pending cardiology approval and psychotherapy to address panic attacks.

The DBS-approved group significantly differed from the non-approved group with four more years of education (d = 1.19). The approved group also demonstrated lower UPDRS score on medication (d = 1.61) and about 20% more improvement on medication (d = 1.48). Of note, both groups did not significantly differ by age or disease duration, giving no indication of bias in the TeleNP DBS evaluation on these characteristics. However, while the initial candidate group was roughly equally Hispanic and non-Hispanic, the approved group was about 47% Hispanic, and the not-approved group was 86% Hispanic.

Table 2 illustrates the characteristics of the 44 post-surgical DBS patients including stage of illness, DBS type, and surgical site. No patients had surgical complications and none were hospitalized more than one day. Nine patients had mild concerns after surgery, which resolved in 2–4 weeks.

Table 3 illustrates neuropsychological characteristics of the different subgroups of the 73 candidates. Statistically significant differences between the 64 approved candidates and the seven patients not approved were found for global cognition, phonemic fluency, and verbal abstract reasoning, showing poorer performance in the unapproved group (with effect sizes ranging from d = 1.18 to 1.36). Overall, TeleNP revealed the not-approved group presented with significantly reduced mental status and impaired verbal generation and analogical reasoning abilities. Depression and anxiety were higher in the non-approved group.

Testing concerns during TeleNP administration were also considered. Twenty-six patients invited a collateral informant for the interview. Twelve percent of cases required a third visit due to fatigue, and in two cases technological issues were present. Overall, patient fatigue was observed in just more than a quarter of all cases. Distraction was reported in two cases (e.g., intrusions into the private testing space by others).

Additionally, a telehealth satisfaction questionnaire was completed by 13 patients (M = 58.6; Md = 60; range = 37–69). The maximum score is 70 on this in-house 10-item Likert survey addressing ease of use, technological concerns, and comfort with procedures. Of the limited number surveyed, most reported satisfaction with the TeleNP option.

Table 2
Post-surgical description of DBS approved group.

Descriptor	Levels	n (N = 44)	%
Hoehn & Yahr	Stage 2	42	95.5
	Stage 3	2	4.5
DBS Type	Bilateral	39	88.6
	Left	4	9.1
	Right	1	2.3
Surgical Site	Subthalamic Nucleus	29	65.9
	Globus Pallidus- Interna	14	31.8
	Cuneiform Nucleus	1	2.3
Intraoperative and Perioperative Complications[a]		0	0
Days hospitalized after surgery	<1 (overnight)	44	100
Concerns after surgery[b]	Total	9	20.5
	Mild Confusion	3	6.8
	Swelling/Wound Care	3	6.8
	Nausea	1	2.3
	Hematoma	1	2.3
	Speech difficulty	1	2.3

Note. [a] May include but not limited to bleeding, transfusion, infection, infection requiring removal of hardware, paralysis, seizure, and anesthetic risks. [b] All concerns resolved within 2–4 weeks post-DBS.

5. Discussion and future directions

Our experience demonstrates that home-to-home TeleNP for pre-DBS screening is a feasible alternative to in-person testing. This modality demonstrated wide range application for PD patients of different ages, disease stage, severity and duration, and dominant language. This is significant, given the rapidly evolving pandemic and the arrival of new variants, which makes providing remote testing critical for continuity of care. All pre-DBS patients seen in our clinic were able to complete neuropsychological evaluations remotely, and 60% of these patients went on to successfully complete DBS, with none having surgical complications.

Our study found that those in the DBS approved group had higher years of education and lower UPDRS scores on medication. This is an incidental finding that warrants future research as cognitive reserve may be serving as a buffer for cognitive decline. Also, since improvement on medication is a predictor of DBS benefit, this finding is likely related to those cases not approved due to major NCD or suspicion of a comorbid disorder (e.g., MSA). Such patients may be less likely to respond to medication in a beneficial or measurable manner, and therefore less likely to benefit from DBS.

Given that our proposed battery of home-to-home TeleNP requires modifications from standard assessment, it is important to consider the validity of tests presented remotely. A meta-analysis conducted by Brearly and colleagues [23] was pivotal in first demonstrating validity and utility of TeleNP. Since then, other studies have examined the validity of TeleNP in adults age 65 and over, which suggested that cognitive screeners and measures of language, attention/working memory, and memory had strong support for TeleNP validity compared to face-to-face administration [24]. TeleNP is a valid and reliable alternative to traditional face-to-face assessment even in patients with cognitive impairment, and in persons with mental status exam scores as low as 15 [25]. This was an important consideration in our study, as PD patients usually have comorbid cognitive changes, and 49.3% of our sample was 65 and older.

The validity of in-home TeleNP testing has also been examined indicating that telehealth scores do not differ significantly from in-person testing, which further supports the use of our current testing model [26,27]. A study conducted by Gardner and colleagues, was the first to demonstrate acceptability and feasibility of direct to home TeleNP in a neuro-oncology clinical sample [28]. This study demonstrated that TeleNP is a feasible practice, while also recognizing limitations in assessing motor and executive functioning. Our analyses allowed for assessment of executive function and was able to capture differences between the approved and not approved group.

Permissions have been granted by some testing publishers given the pandemic regarding adaptation to standard testing [12,14,26], and all patients, caregivers, and referring providers are informed of the limitations. Despite these deviations from standard administration, our findings indicate that we were able to successfully assess for cognitive and emotional functioning using telehealth. Our patients ranged in age from 39 to 79, had from 6 to over 20 years of education, and nearly half were Hispanic (30 Spanish speaking monolingual), indicating that this modality can be applied to a broad range of demographically diverse patients. A recent study has described the implementation process of

Table 3
Pre-surgical neuropsychological assessments compared by group.

	Eval (n = 73)	Appr (*n* = 64)	Comp (*n* = 44)	Sched (n = 11)	Decl (*n* = 9)	NApp (*n* = 7)	Cond (*n* = 2)	*p*: Appr vs. NApp[a]
Global Cognition								
MoCA (raw)	23.9 (4.73)	24.5 (4.05)	25.0 (4.34)	23.6 (2.20)	23.7 (4.36)	17.3 (6.16)	26.5 (0.70)	.001 (*d* = 1.18)
Attention/Working Memory								
WAIS-IV Digit Span (ss)	8.89 (3.06)	10.8 (3.39)	9.41 (2.87)	9.18 (3.74)	8.78 (2.39)	5.57 (2.64)	8.00 (0)	.003
Language								
BNT (T)	46.9 (15.4)	47.8 (15.2)	48.8 (13.8)	39.6 (5.87)	54.9 (26.7)	37.3 (17.7)	52.5 (4.95)	.198
COWAT- FAS/PTM (T)	40.7 (17.1)	43.3 (16.1)	42.0 (17.0)	45.1 (15.6)	47.7 (12.1)	19.0 (12.1)	32.5 (7.78)	< .001 (*d* = 1.36)
COWAT- Animals (T)	45.8 (13.1)	46.3 (13.1)	49.3 (11.2)	40.4 (15.8)	39.0 (14.7)	43.3 (14.6)	39.5 (2.12)	.407
Visuospatial Skills								
WAIS-IV Matrix Reasoning (ss)	9.11 (3.03)	9.40 (2.80)	9.49 (2.88)	8.82 (2.89)	9.67 (2.50)	6.43 (4.24)	9.50 (0.71)	.033
Memory								
CVLT-3[b] Trials 1–5 (SS)	92.4 (14.3)	94.2 (12.9)	96.0 (12.8)	90.5 (14.8)	91.3 (10.4)	74.0 (21.6)	83.0 (11.3)	.005
CVLT-3[a] Short Delay Free Recall (ss)	8.74 (2.96)	8.94 (2.85)	9.50 (2.99)	8.00 (2.58)	7.88 (2.10)	8.50 (3.54)	6.50 (2.12)	.333
CVLT-3[a] Long Delay Free Recall (ss)	8.18 (3.10)	8.37 (3.01)	9.31 (2.69)	6.33 (2.92)	6.88 (2.90)	5.00 (2.94)	7.50 (0.71)	.054
WMS-IV LM1 (ss)	8.75 (3.51)	9.02 (3.55)	9.41 (3.18)	9.55 (4.20)	6.44 (3.75)	7.71 (2.43)	4.00 (0)	.089
WMS-IV LM2 (ss)	8.71 (3.56)	9.14 (3.41)	9.34 (3.24)	9.64 (4.15)	7.56 (3.21)	6.29 (3.45)	3.50 (0.71)	.005
Executive Functioning								
WAIS-IV Similarities (ss)	10.3 (3.61)	10.8 (3.39)	11.1 (3.26)	10.7 (4.67)	9.50 (2.00)	5.83 (3.37)	9.00 (1.41)	.001 (*d* = 1.25)
Oral Trails B (T)	45.8 (15.1)	46.4 (15.5)	48.3 (13.9)	44.4 (21.0)	40.6 (14.4)	38.6 (6.88)	35.5 (2.12)	.272
Emotional Functioning								
BDI-II (raw)	9.97 (9.14)	8.90 (8.29)	8.48 (8.48)	9.64 (9.87)	10.3 (4.92)	20.0 (13.3)	13.5 (0.71)	.005
BAI (raw)	14.8 (11.7)	13.5 (11.0)	13.0 (11.0)	12.5 (9.63)	17.1 (12.7)	24.3 (15.4)	23.0 (2.83)	.011

Note. Eval = evaluated for surgery; Appr = approved for surgery; Comp = completed surgery; Decl = patient declined surgery; NApp = not approved for surgery; Cond = conditionally approved for surgery; ss = scaled score; T = T-score; MoCA = Montreal Cognitive Assessment; WAIS-IV = Wechsler Adult Intelligence Scale (4th Edition); BNT = Boston Naming Test; COWAT-Animals = Controlled Oral Word Association Test- Animals; COWAT FAS/PTM = Phonemic Fluency (English/Spanish); CVLT-3 = California Verbal Learning Test- 3rd Edition; WMS-IV LM1 & 2 = Wechsler Memory Scale (Logical Memory 1 & 2), 4th Edition; BDI-II = Beck Depression Inventory- 2nd Edition; BAI = Beck Anxiety Inventory. [a] CVLT-II (4) or MAMI (Miami Attention and Memory Instrument; 5) results substituted in specified cases. [b] Significant differences denoted in bold type per Student's *t* with $p < .003$ (Bonferroni adjusted).

TeleNP models of care across 5 U S. academic institutions for multicultural patients including Hispanic/Latino [29]. Our study adds to this foundation and demonstrates that TeleNP can successfully screen PD patients that are primarily Spanish-speaking for surgical candidacy.

Neuropsychological assessment results impact decision making on a multidisciplinary team. Research has demonstrated that the main reasons patients with PD are not approved for surgery include cognitive contraindications (32.7%), neurobehavioral/psychiatric concerns (21.3%), and unrealistic/unfeasible patient goals (9.8%) [30]. Our home-to-home TeleNP pre-DBS evaluations were able to effectively screen for candidacy and successfully excluded those with moderate to severe dementia, uncontrolled mood disorders, and active psychosis, factors we know are linked to poor surgical prognosis.

Though TeleNP has allowed for the resumption of services to assess for DBS candidacy in a timely manner, and therefore has reduced time to surgery and improved patient quality of life, TeleNP may not be viable for all patients. We recognize the limitations that remote assessment can create in terms of problems with connection, environmental issues, and confidentiality. TeleNP may amplify social and cultural disparities due to access to care, lack of technological equipment, or discomfort with remote testing. More work is also needed to assess reliability and validity of home-to-home TeleNP, as well as a comparison of face-to-face evaluations when assessing for DBS candidacy. Future studies are also needed to improve health equity through community partnerships, education and training for digital literacy, and improved access to language services.

This study presents information on the creation and successful implementation of a sensitive, feasible, and accepted method of screening that can be implemented across the country for pre-DBS evaluations. We believe that home-to-home TeleNP will change healthcare practices now and in the future as they allow for no direct patient contact, mobility related equity, and increased collateral involvement for optimal patient care. Though the challenges posed by COVID-19 are large, we believe the feasibility and acceptance of this modality of evaluation has transformed standard of care during COVID-19, and we predict this method of care will transcend this historical period.

Funding source

Dr. Luca has received funding from the Parkinson's Foundation and Medtronic educational grant. These funding sources had no involvement in the study design, collection, analysis or interpretation of the data, in writing the manuscript, or in the decision to submit the paper for publication.

Declaration of competing interest

None.

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