



Original Research

Evaluation of an Interdisciplinary Screening Program for People With Parkinson Disease and Movement Disorders



Uzma Khan, OTR/L^a, Laura Stoff, MPH^a,
J. Diego Yahuaca, BSc^b, Bavna Bhagavat, BSc^{a,c},
Santiago Toledo, MD^{a,d}, Jennifer G. Goldman, MD, MS^{a,b,d,e},
Tanya Simuni, MD^{b,e}, Miriam Rafferty, DPT, PhD^{a,d}

^a Shirley Ryan AbilityLab, Chicago, Illinois

^b Northwestern University Feinberg School of Medicine, Chicago, Illinois

^c Chicago Medical School at Rosalind Franklin University of Medicine and Science, North Chicago, Illinois

^d Northwestern University Department of Physical Medicine and Rehabilitation, Chicago, Illinois

^e Northwestern University Department of Neurology, Chicago, Illinois

KEYWORDS

Parkinson disease;
Rehabilitation

Abstract Objective: To describe the characteristics of people with Parkinson disease and movement disorders (PDMDs) referred by neurologist to a physiatrist-led interdisciplinary rehabilitation screening program.

Design: Retrospective data analysis of electronic health records (EMRs).

Setting: Outpatient PDMD neurology clinic and an interdisciplinary rehabilitation hospital's PDMD screening program.

Participants: People with PDMDs referred by neurologists to the interdisciplinary rehabilitation screening program from 2009-2017 (n=934), with early referrals from 2009-2015 (n=449) and

List of abbreviations: EMR, electronic medical record; MD, movement disorder; OT, occupational therapy; PD, Parkinson disease; PT, physical therapy; SLP, speech language pathology; TUG, timed Up and Go.

Supported in part by the National Institutes of Health's National Center for Advancing Translational Sciences (grant no. UL1TR001422), the Northwestern University Parkinson's Disease and Movement Disorder Center, the Agency for Healthcare Research and Quality (Rafferty: F32HS025077), and the Foundation for Physical Therapy (Rafferty: New Investigator Fellowship and Training Initiative 2016-2018). The content is solely the responsibility of the authors and does not necessarily represent the official views of any sponsor.

Disclosures: Dr Goldman reports grants from NINDS, MJFF, Parkinson's Foundation, CHDI, Biotie, Acadia, Aptinyx, Sunovion, and Worldwide Med during the conduct of the study. Dr Simuni reports grants from NINDS, MJFF, Parkinson's Foundation, Biogen, Roche, Neuroderm, Sanofi, Sun Pharma, Abbvie, IMPAX, Prevail, Acadia, Abbvie, Accordia, Adamas, Allergan, Amneal, Aptinyx, Denali, General Electric, Kyowa, Neuroderm, Neurocrine, Sanofi, Sinopia, Sunovion, Roche, Takeda, Voyager, and US World Meds during the conduct of the study. Dr Rafferty reports grants from Northwestern University, Department of Neurology, during the conduct of the study; grants and personal fees from Parkinson's Foundation; and grants from the Foundation for Physical Therapy, Davis Phinney Foundation, and Agency for Healthcare Research and Quality outside the submitted work. The other authors have nothing to disclose.

Cite this article as: Arch Rehabil Res Clin Transl. 2020;2:100067.

<https://doi.org/10.1016/j.arrct.2020.100067>

2590-1095/© 2020 The Authors. Published by Elsevier Inc. on behalf of the American Congress of Rehabilitation Medicine. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

recently referred from 2015-2017 ($n=485$), and patients who had new interdisciplinary rehabilitation screening program evaluations from 2015-2017 ($n=183$).

Intervention: Participation in the physiatrist-led PDMD screening clinic.

Main Outcome Measures: Demographics, disease-related features, timed Up and Go, conversational voice volume, recommended therapy services, and number of therapies completed 90 days following interdisciplinary rehabilitation screening program.

Results: People referred from the neurologists to the interdisciplinary rehabilitation screening program from 2009-2017 were 72 ± 12.9 years old, male (56%), white (65%), and with 1 or more comorbidities (62%). Compared with early referrals from 2009-2015, more recently referred participants from 2015-2017 were younger ($P<.001$) and earlier in disease duration ($P=.036$). The interdisciplinary rehabilitation screening program participants from 2015-2017 had mean timed Up and Go time of 15.4 ± 10.1 seconds and a mean conversational voice volume of 68.98 ± 4.7 dB.

Conclusions: The interdisciplinary rehabilitation screening program was sustained with increased number of referrals over time, occurring earlier in the disease in more recent years. Key strategies used to sustain the program over time include development of a unique referral order set for the neurologists, implementation of a comprehensive screen tool in the rehabilitation hospital EMR, and centralized communication through social workers at both facilities.

© 2020 The Authors. Published by Elsevier Inc. on behalf of the American Congress of Rehabilitation Medicine. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

The benefits of team-based rehabilitation incorporating different disciplines for people with Parkinson disease (PD) and movement disorders (MDs) have been recognized for over 15 years.^{1,2} Interdisciplinary care, with the close coordination of rehabilitation disciplines and direct interactions among providers, as well as multidisciplinary care, which includes multiple team members who may work in parallel but do not necessarily have direct interactions with each other, have both been shown to improve mobility, decrease caregiver burden, and maintain quality of life in PD.¹⁻³ For example, people with PD treated by a multidisciplinary specialist team maintained improvements in their Parkinson's Disease Questionnaire-39 and Unified Parkinson Disease Rating Scale scores compared with the control group who received usual care from a neurologist.⁴

Interdisciplinary rehabilitation services are recommended for people with Parkinson disease and movement disorders (PDMDs).⁵ However, health care system separation and space constraints between specialty MD neurology clinics and rehabilitation providers can make it difficult to integrate these services. In 2006, the need to integrate expert interdisciplinary screening and rehabilitation services for people with PDMDs was identified by an urban academic MD neurology center at Northwestern University, as well as the physiatrists and Allied Health clinicians at the Shirley Ryan AbilityLab, formerly Rehabilitation Institute of Chicago. Shirley Ryan AbilityLab is a freestanding interdisciplinary rehabilitation hospital that is academically affiliated with Northwestern. In 2007, the 2 organizations began new referral and screening processes creating a physiatrist-led interdisciplinary rehabilitation screening program for people with PDMDs to help them navigate their rehabilitation needs (fig 1).

The objectives of this study are to (1) describe our interdisciplinary rehabilitation screening program for people with PDMDs, (2) characterize the people with PDMDs

referred to and attending the interdisciplinary rehabilitation screening program, (3) describe how the program has changed over time, and (4) identify the rehabilitation services used by people with PDMDs who participated in the initial screening using retrospective data analysis from electronic medical records (EMRs).

Methods

Participants and data sources

The neurologists and interdisciplinary rehabilitation hospital used unique EMR systems. The first data source was the neurologists' EMR. Participants from 2007-2017 were included for analysis if they had an electronic referral for the interdisciplinary rehabilitation screening program (inception of EMR order set July 1, 2009), with no further exclusion criteria.

The second data source was the interdisciplinary rehabilitation hospital EMR. Participants were included if they had a PDMD diagnosis (see [supplemental table S1](#) for *International Classification of Diseases—9th/10th Revision* list, available online only at <http://www.archives-pmr.org/>) and had a new interdisciplinary rehabilitation screening program evaluation scheduled between March 1, 2015, and December 31, 2017. Prior to March 1, 2015, paper records were used. To be included in analyses, participants were required to have all of the following EMR forms: (1) scanned neurology evaluation or progress note, (2) scanned neurology referral to interdisciplinary rehabilitation screening program, (3) EMR interdisciplinary rehabilitation screening program physiatrist evaluation, and (4) EMR interdisciplinary team screening document. There were no further exclusion criteria. For all individuals with complete documentation of their interdisciplinary rehabilitation screening program process, we

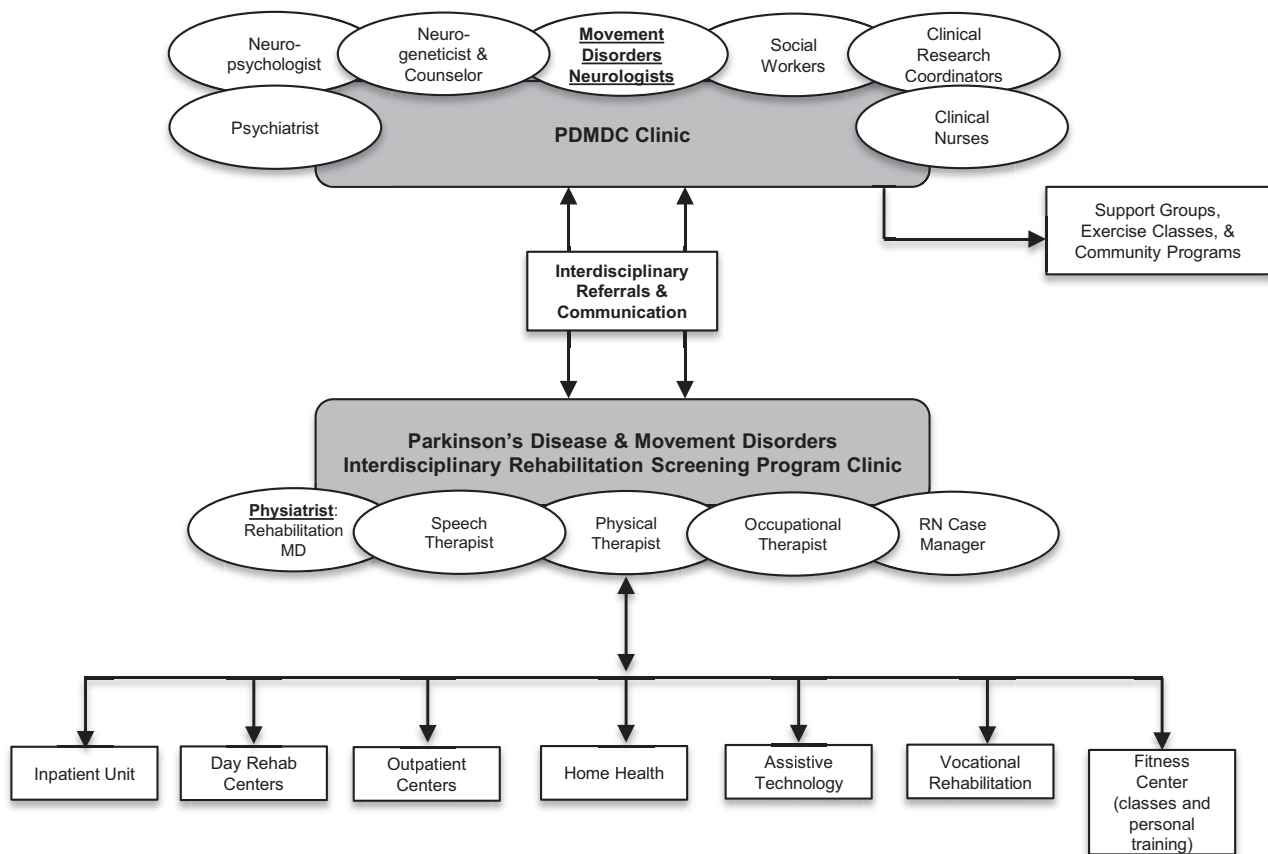


Fig 1 Organizational chart of Parkinson's Disease and Movement Disorders Center and inpatient rehabilitation screening program. Ovals represent clinicians, and boxes represent clinical and community services. Abbreviations: IRSP, interdisciplinary rehabilitation screening program; PDMDC, Parkinson's Disease and Movement Disorders Center.

extracted subsequent interdisciplinary rehabilitation hospital notes for all physician and allied health therapy visits occurring at clinical site and levels of care within the Shirley Ryan AbilityLab system.

The Northwestern University Institutional Review Board, which also oversees Shirley Ryan AbilityLab research, approved the protocol for this retrospective data analysis. Informed consent was waived because of the retrospective nature of this study.

Interdisciplinary rehabilitation screening program process

The process for the interdisciplinary rehabilitation screening program includes the following steps:

- (1) People with PDMDs are referred by MD neurologists to the interdisciplinary rehabilitation screening program at the discretion of the neurologists. The 2 organizations have distinct EMRs, and the neurology clinic nurse provides care coordination and faxes referrals and medical notes to the rehabilitation team.
- (2) Referred individuals are scheduled for an approximately 2-hour visit with an interdisciplinary team consisting of a psychiatrist, nurse, physical therapist,

- occupational therapist, speech language pathologist, and a care coordinator. The psychiatrist completes a 45-minute initial evaluation including review of history; general systems overview; review of PD symptoms; current exercise and therapy diet; and review of medication, personal care, and work/leisure activities. The nurse records participant's vitals and medications. The therapists complete a 45-minute therapy coscreen consisting of the following:
- a. Occupational therapy (OT): Description of home environment, assistive device use, activities of daily living, instrumental activities of daily living, report of current problems, upper extremity range of motion, strength and coordination testing.
 - b. Speech therapy: Measure conversational voice volume, voice volume with sustained, memory recall, auditory comprehension, report of clinical signs of aspiration, clinical signs of aspiration, clock drawing.
 - c. Physical therapy (PT): Review assistive device use related to walking, report of falls, report of current problems. Tests lower extremity range of motion, strength and coordination, 5 times sit to stand test, timed Up and Go (TUG) test.
- (3) A team conference is conducted to formulate recommendations to manage the specific needs of the

person with PDMDs. In collaboration with the participant and caregiver, if present, a collective decision is made regarding the following: referral to therapies and ancillary services, determination of the level of care of rehabilitation, and recommendations for timing of therapy services (immediate vs delayed) based on the person with PDMDs and caregiver's needs. In addition to therapy services, the interdisciplinary rehabilitation screening program refers to adjunct services, including community-based fitness programs, driver's rehabilitation, video fluoroscopic swallow study, social worker, neuropsychology, assistive technology, wheelchair and adaptive seating evaluations, and vocational rehabilitation, as necessary.

- (4) The care coordinator assists in coordinating the schedule of therapies across affiliated rehabilitation sites (urban and suburban locations) and coordinates written documentation of the return visit to the referring MD neurologists.
- (5) Follow-up visits with the physiatrist are recommended as needed from the initial visit. Referred individuals continued to see their referring neurologist as required.
- (6) Team members from the neurologists and the interdisciplinary rehabilitation screening program meet monthly for program planning.

Measures obtained from EMR

Demographic data extracted from the neurologist's EMR at the time of interdisciplinary rehabilitation screening program referral included age, sex, PDMD diagnosis, years since PDMD diagnosis was added to neurologist's EMR, and number and type of comorbidities. Demographic data extracted from the interdisciplinary rehabilitation screening program data included age, sex, PDMD diagnosis category, and payer mix.

Rehabilitation measures obtained during interdisciplinary rehabilitation screening program screening included the following: conversational voice volume (measured in dB)⁶; history of falls (dichotomized as yes/no); report of living situation (categorized as caregiver, spouse, children, self, significant other, parent(s)/guardian), and mobility scored using the TUG test measured in seconds.⁷

Outcomes of the interdisciplinary rehabilitation screening program included the recommended setting for subsequent therapy delivery (ie, outpatient, inpatient, or home health care), as well as any adjunct services. When the recommended therapy was delivered within the interdisciplinary rehabilitation hospital system, the number of therapy visits completed following interdisciplinary rehabilitation screening program was reviewed.

Statistical analyses

First, we used descriptive statistics to characterize all individuals referred by the neurologists from 2009-2017. Second, we identified individuals referred by neurologists to the interdisciplinary rehabilitation screening program

from December 9, 2014, to December 31, 2017. Two groups were identified: early referrals (2009-2014) were individuals referred by neurologists prior to the initiation of electronic documentation, and recent referrals (2015-2017) were individuals referred who would attend the interdisciplinary rehabilitation screening program after implementation of electronic documentation. These recent referrals were compared with the individuals referred by neurologists from 2009-2014 (early referrals). Comparisons were made using 2-tailed unpaired *t* tests and chi-square tests, where appropriate. Third, we used descriptive statistics to characterize the interdisciplinary rehabilitation screening program participants from 2015-2017, including demographic and disease characteristics, rehabilitation measures at the time of screening, rehabilitation recommendations, and rehabilitation utilization patterns following screening.

Results

Figure 2 outlines the distribution of referrals from the neurologists, the interdisciplinary rehabilitation hospital, and the overlapping interdisciplinary rehabilitation screening program participants.

Neurologist referral participants

A total of 934 people with PDMDs were referred from the neurologists to the interdisciplinary rehabilitation screening program from July 8, 2009, to December 31, 2017, with a mean age of 72 ± 12.9 years. The majority were male, white, and married and had 1 or more comorbidities at the time of referral (table 1). A total of 41% were insured by Medicare; 63% of patients ($n=688$) had a primary diagnosis of idiopathic PD. Missing definitive diagnoses occurred in 112 (12%). Other included diagnoses were corticobasal syndrome (4%), tremor (3%), secondary parkinsonism (3%), dementia (2%), and less than 1% each of multiple system atrophy, Huntington disease, and Wilson disease. The most common comorbid conditions were related to cardiovascular disease, dementia, and mood disorders (table 2). The number of people referred by their neurologist to the interdisciplinary rehabilitation screening program increased from 94 in its first year, 2010, to 216 people in 2017, which was also accompanied by an increase from 1 to 4 physiatrists on the team. The average yearly volume increase in the interdisciplinary rehabilitation screening program was 20% (-33% to 56%), while the neurology clinic reported average yearly volume growth of approximately 10%.

Comparison of patients referred by neurologists to the interdisciplinary rehabilitation screening program from 2009-2014 vs 2015-2017

There were 449 neurologist referrals from 2009-2014 and 485 neurologist referrals from 2015-2017. Table 1 describes all patients with neurologist referrals, regardless of missing fields, and compares the early referrals with the more recent referrals. People referred in more recent years

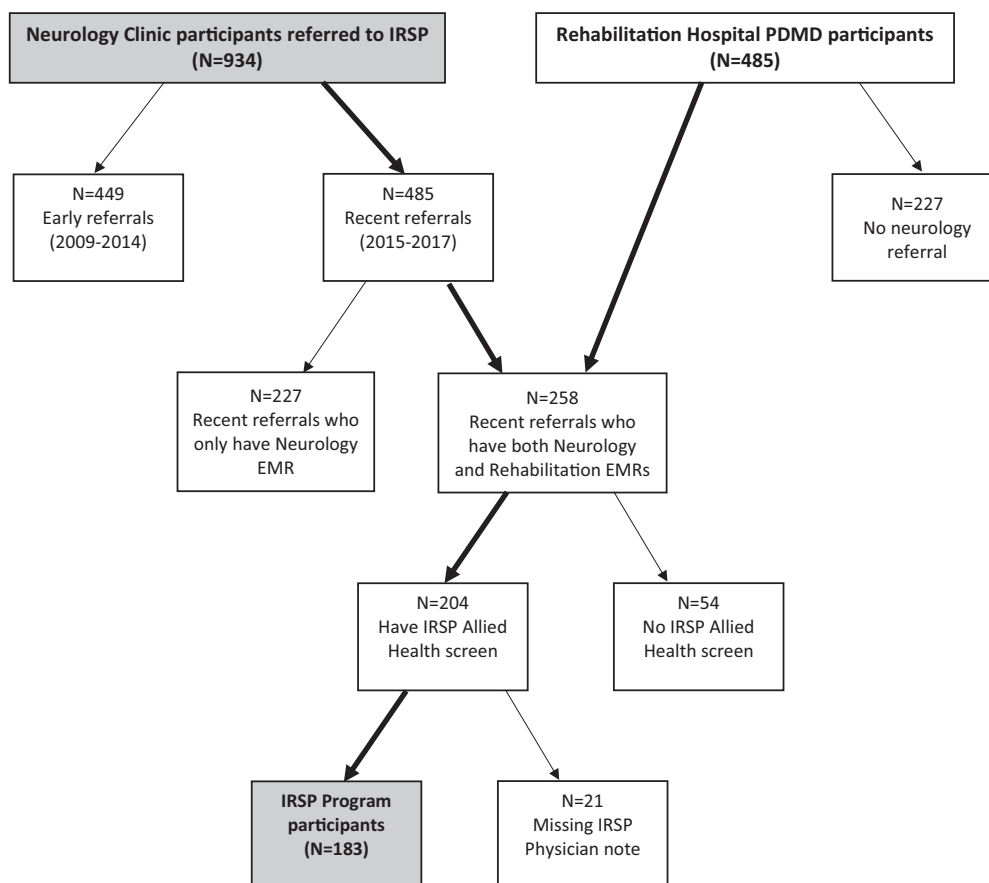


Fig 2 CONSORT diagram. Diagram outlines EMR sources and numbers of interdisciplinary rehabilitation screening program participants with PDMDs. Gray boxes represent the neurology referral cohort and IRSP program participants who are described in the article. Dark arrows represent the path of data extraction. Abbreviations: CONSORT, Consolidated Standards of Reporting Trials; IRSP, interdisciplinary rehabilitation screening program.

(2015-2017) were younger and earlier in their diagnosis at the time of referral compared with patients who were referred to the interdisciplinary rehabilitation screening program in its earlier years (2009-2014).

Interdisciplinary rehabilitation hospital patients and interdisciplinary rehabilitation screening program participants

After removing records that were missing physician or therapy documentation, there were 183 people with complete records included in the final analyses of interdisciplinary rehabilitation screening program participants. Table 3 shows that a majority of the interdisciplinary rehabilitation screening program participants were white (53%), male (61%), and diagnosed as having idiopathic PD (82%).

The interdisciplinary rehabilitation screening program documentation indicated that 23% lived alone ($n=36$), and 64% reported a history of falls at the time of the evaluation ($n=114$). Rehabilitation measures captured at the time of the interdisciplinary rehabilitation screening program experience included conversational voice volume (mean, 68.98 ± 4.7 dB) and TUG test (mean, 15.39 ± 10.1 s). A total of 32% ($n=58$) of people were referred for a video

fluoroscopic swallow study indicating concern regarding swallowing functions based on history and clinical examination with observation and palpation of a swallow.

Rehabilitation service recommendation patterns following interdisciplinary rehabilitation screening program

Following the interdisciplinary rehabilitation screening program experience, 98% of individuals were referred to at least 1 rehabilitation service. Most individuals were referred to multiple outpatient disciplines (60%) or an interdisciplinary day rehabilitation setting (33%) (fig 3). Within multidisciplinary outpatient referrals, the most common combination of therapies was PT and speech language pathology (SLP) therapy ($n=35$ of 106; 33%). When a single therapy was recommended, PT was most common ($n=26$ of 30 single-discipline referrals). In the interdisciplinary day rehabilitation setting, in which a minimum of 2 disciplines are required and scheduled on the same day, all 3 therapies were included in 95% of all day rehabilitation referrals. Inpatient rehabilitation hospital admissions and home health therapy received the fewest referrals (5% and 2%, respectively).

Table 1 Neurology clinic participants: characteristics by referral time

Characteristics	All (N=934)	Early Referral Group (n=449)	Recent Referral Group (n=485)	P Value*
Age (y), mean \pm SD	72.3 \pm 12.9	74.3 \pm 12.9	70.4 \pm 12.7	<.001
Disease duration (y), mean \pm SD [†]	1.55 \pm 0.1	1.73 \pm 2.5	1.37 \pm 2.5	.036
PDMD diagnosis, n (%)				
Idiopathic PD	588 (63.0)	350 (78)	238 (49.1)	<.001
Other	144 (15.4)	48 (10.7)	96 (19.8)	
Missing	202 (21.6)	51 (11.4)	151 (31.1)	
Sex, n (%)				
Female	409 (43.8)	203 (45.2)	206 (42.5)	.399
Race, n (%)				
White	609 (65.2)	301 (68.9)	308 (63.6)	.004
Black	67 (7.2)	30 (6.9)	37 (7.6)	
Asian	41 (4.4)	21 (4.8)	20 (4.1)	
Other	68 (7.3)	24 (5.5)	44 (9.1)	
Declined/unknown	147 (15.7)	73 (16.3)	76 (15.7)	
Ethnicity, n (%)				
Hispanic/Latino	58 (6.2)	19 (4.4)	39 (8.0)	.001
Not Hispanic/Latino	696 (74.5)	333 (77.1)	363 (74.9)	
Declined/unknown	180 (19.3)	97 (21.6)	83 (17.1)	
Marital status, n (%)				
Married	585 (62.6)	279 (62.1)	306 (63.1)	.001
Single, divorced, or widowed	230 (24.6)	128 (28.5)	102 (21.0)	
Other	11 (1.2)	1 (0.2)	10 (2.1)	
Declined/unknown	108 (11.6)	41 (9.1)	67 (13.8)	
Insurance, n (%)				
Blue Cross Blue Shield	111 (11.9)	25 (5.6)	86 (17.7)	<.001
Other commercial	19 (2.0)	11 (2.5)	8 (1.7)	
Managed care	28 (3.0)	0 (0.0)	28 (5.8)	
Medicaid	13 (1.4)	0 (0.0)	13 (2.7)	
Medicare	379 (40.6)	70 (15.6)	309 (63.8)	
Self-pay or unknown	384 (41.1)	343 (76.4)	41 (8.5)	
Comorbidities, n (%)				
0-3	607 (65.0)	282 (62.8)	325 (67.0)	.359
4-9	201 (21.5)	94 (20.9)	107 (22.1)	
10-15	69 (7.4)	36 (8.0)	33 (6.8)	
16+	57 (6.1)	37 (8.2)	20 (4.1)	

NOTE. Two-sided unpaired *t* tests and χ^2 tests were used to compare the Early and Recent Referral Groups' normally distributed and categorical data, respectively.

* *P* values refer to comparisons between Early Referral Group and Recent Referral Group.

[†] Disease duration was calculated for n=822 with PDMD diagnosis, based on the date entered in the neurologist electronic medical record, which may underestimate time since diagnosis from a prior physician. For disease duration data: n=398 for Early Referral Group; n=424 for Recent Referral Group.

Rehabilitation service utilization patterns following interdisciplinary rehabilitation screening program

Within the 90 days following their interdisciplinary rehabilitation screening program evaluation, 95 people (52%) started rehabilitation care at an outpatient, day rehabilitation, or inpatient rehabilitation site affiliated with the interdisciplinary rehabilitation screening program itself. For the 50 individuals who used outpatient rehabilitation, the average number of visits was 7 \pm 7 for PT (range, 1-29; n=41), 2 \pm 4 for OT (range, 1-36; n=14), and 4 \pm 7 for SLP therapy (range, 1-19; n=32). Of the 37 individuals using day rehabilitation, average enrollment was 48 \pm 21 days (range, 16-136d) with therapy 2-3 visits per week. Of the

8 individuals completing inpatient rehabilitation, the average length of stay was 18 \pm 6 days (range, 9-28d) with therapies provided 5 or more days per week.

Discussion

This health services study describes an interdisciplinary screening program for PDMD, changes in the program over time, characteristics of people referred to and screened by an interdisciplinary rehabilitation screening program, and rehabilitation services provided to the people who attended the interdisciplinary rehabilitation screening program. In recent years, there has been increased participation in

Table 2 Comorbidity characteristics of all neurologist referrals

Characteristics	ICD-10 Codes	Count	% of Total Patients	% of Category
Cardiovascular*		365	39.1	
Hypertension	I10-I16, I27	205	21.9	56.2
Cerebrovascular disorders	I60-I69	106	11.3	29.0
Other cardiovascular disorders	I	94	10.1	25.8
Hypotension	I95	88	9.4	24.1
Atherosclerosis	I70	67	7.2	18.4
Arrhythmias	I46 – I49	66	7.1	18.1
Thrombotic/embolic disorders	I74-I76, I80-I82	33	3.5	9.0
Valvular disorders	I05-I09, I34-I37	24	2.6	6.6
Peripheral vascular disease	I73	15	1.6	4.1
Aortic disorders	I71	13	1.4	3.6
Dementia*		345	36.9	
Vascular dementia	F01	187	20.0	54.2
Other dementia	F02-F05, G30-G31	144	15.4	41.7
Mild cognitive impairment	G31.84	106	11.3	30.7
Lewy body dementia	G31.83	32	3.4	9.3
Mood disorders*		286	30.6	
Depression	F32-F34	213	22.8	74.5
Anxiety	F41	107	11.5	37.4
Other mood disorders	F25, F39, F40, F43	35	3.7	12.2
Mania/bipolar	F30-F31	18	1.9	6.3
Urologic/renal*		271	29.0	
Other urologic/renal disorders	R30-R39, N20-N39, R80-R82, R94.4	162	17.3	59.8
Urinary urgency	R39.15, N31, N32.81, N39.41	91	9.7	33.6
Primary prostate disorders	N40-N42	76	8.1	28.0
Primary renal disorders	N00-N19	68	7.3	25.1
Urinary retention	R33, N32.0, N13	43	4.6	15.9
Urinary frequency	R35.0	41	4.4	15.1
Urinary tract infection	N39.0	35	3.7	12.9
Stress incontinence	N39.3, N35	7	0.7	2.6
Sleep disorders*		258	27.6	
REM sleep behavior disorder	G47.52	118	12.6	45.7
Other sleep disorders	G47, F51, F19.182	80	8.6	31.0
Insomnia	G47.0, F51.0	75	8.0	29.1
Sleep apnea	G47.3	70	7.5	27.1
Somnolence/hypersomnia	G47.1, R40.0, F51.1	48	5.1	18.6
Joint pain		234	25.1	
Axial pain	M25.0, M54.1, M54.2, M54.5, M54.6, M54.8, M54.9	136	14.6	58.1
Lower limb pain	M25.1, M25.2, M25.3, M25.4, M79.601, M79.602, M79.603, M79.62, M79.63, M79.64	82	8.8	35.0
Upper limb pain	M25.55, M25.56, M25.57, M79.604, M79.605, M79.606, M79.65, M79.66, M79.67	65	7.0	27.8
Cancer and neoplasia		180	19.3	
Skin cancer	C43, C44, C4A	60	6.4	33.3
Other cancer/neoplasia	C00-D49	57	6.1	31.7
Prostate cancer	C61	38	4.1	21.1
GI cancer	C15-C26	38	4.1	21.1
Breast cancer	C50, D05	36	3.9	20.0
Hematologic cancer	C81-C96	14	1.5	7.8
Brain cancer	C69-C72	13	1.4	7.2
Musculoskeletal cancer	C40-C41	6	0.6	3.3
Ophthalmologic*		120	12.8	
Other ophthalmologic disorders	H	75	8.0	62.5
Eye adnexa disorders	H00-H05	44	4.7	36.7
Cataracts	H25-H28	41	4.4	34.2

(continued on next page)

Table 2 (continued)

Characteristics	ICD-10 Codes	Count	% of Total Patients	% of Category
Eye movement disorder	H49-H52	32	3.4	26.7
Glaucoma	H40-H42	28	3.0	23.3
Macular degeneration	H35.3	19	2.0	15.8
Diabetes mellitus*	E08-E13	90	9.6	
Thyroid disorder*		80	8.6	
Hypothyroidism	E02-E03	62	6.6	77.5
Other thyroid disorders	E00-E07	25	2.7	31.3
Arthritis*		59	6.3	
Osteoarthritis	M15-M19	49	5.2	83.1
Rheumatoid arthritis	M05-M06	11	1.2	18.6
Hepatic disorders*		56	6.0	
Viral hepatitis	B15-B19	48	5.1	85.7
Other hepatic disorders	K70-K77, R94.5	10	1.1	17.9
Cirrhosis	K74	4	0.4	7.1
Obesity*	E65-E66	18	1.9	

NOTE. All ICD-9 codes were converted to ICD-10 codes. ICD-10 codes listed above include all ICD-10 subcodes within the mentioned ICD-10 parent code. The ICD-10 code categories above are presented as individual parent codes or ranges of codes when applicable.

Abbreviations: ICD-9, *International Classification of Diseases—9th Revision*; ICD-10, *International Classification of Diseases—10th Revision*.

* Within condition categories, the subcategory labeled "other" includes any comorbidity in the condition category that was not already listed (eg, Other cardiovascular disorders includes all codes within the "I" ICD-10 parent code except for codes listed above it in subcategories, such as Peripheral vascular disease, Atherosclerosis, Hypertension, etc).

the interdisciplinary rehabilitation screening program, doubling the number of referrals. This programmatic growth may be because of increased referrals from the neurologists and increased interest from people with PD in rehabilitation services. The volume growth of the interdisciplinary rehabilitation screening program was twice the volume growth of the neurology clinic alone, suggesting the increased referrals could be because of increased rate of referral from neurologists and increased interest in rehabilitation from people with PD. Furthermore, the individuals referred in more recent years were earlier in their diagnosis and younger. These trends are consistent with recent clinical practice guidelines and quality indicators recommending earlier referral or discussion of rehabilitation services,⁸⁻¹⁰ as well as growth in the evidence encouraging early exercise in PD.¹¹

Key strategies contributed to the sustainability of the interdisciplinary rehabilitation screening program. First, creating a unique order set for the referring neurologists allowed for clear communication between the 2 independent EMR systems. Second, implementation of a comprehensive screening tool in the EMR at the rehabilitation hospital enabled efficient screening. Third, centralized communication through the social worker allowed for ease in follow-up for staff and participants.

A total of 91% of the interdisciplinary rehabilitation screening program participants were referred to outpatient multidisciplinary or outpatient interdisciplinary day rehabilitation care, which is strongly supported in the literature because of the multifactorial nature of the problems and symptoms associated with PDMD.^{2,12,13} PT was the most common therapy service recommended. This is supported by the high fall risk of the screened individuals, with 60%

having a history of falls and an overall mean TUG time of 15.4 seconds compared with fall risk cutoff scores of 13.5 seconds in healthy older adult populations and 11.7 seconds in populations with PD.^{14,15} The interdisciplinary rehabilitation screening program participants also had softer speech as indicated by lower mean conversational voice volume (68.98 ± 4.7 dB) compared with normal values in older adults of 74.0 dB, indicating a potential for successful voice therapy treatment.⁶ Furthermore, the combination of fall risk factors and living alone signal a need for instituting safety measures, assessing durable medical equipment needs, and strategizing regarding task modifications, which are areas that can be addressed by OT and PT. Greater levels of referral to all therapies in this cohort compared with national trends, particularly to SLP and OT services, indicates that the interdisciplinary screening process may be a successful strategy to increase participation in the more underused services.¹⁶

Of the 183 new interdisciplinary rehabilitation screening program participants seen from 2015-2017, only 8 individuals attended the inpatient rehabilitation program. Prior research at this center described 89 people admitted during a 5-year period from 2004-2008.¹⁷ The larger number of inpatient rehabilitation patients reported in the prior study is likely because of our exclusion of people with PDMD from the interdisciplinary rehabilitation screening program cohort if they entered the system of care following an acute hospitalization rather than directly from an outpatient neurology referral. In recent years, there have been more restrictive insurance guidelines in the United States limiting direct admissions from home. Several studies support the benefits of intensive inpatient rehabilitation programs for PD, although logistics and feasibility may differ

Table 3 IRSP participant characteristics (N=183)

Characteristics	n (%) or Mean \pm SD
Age (y)	73.6 \pm 9.1
Sex	
Female	71 (38.8)
Male	112 (61.2)
PDMD diagnosis	
Idiopathic PD	150 (82)
Parkinsonism	15 (8.2)
PSP	4 (2.2)
MSA	4 (2.2)
DLB	7 (3.8)
CBD	1 (0.6)
Other (essential tremor and gait disorder)	2 (1.1)
Race	
Asian	4 (2.2)
Black	12 (6.6)
White	97 (53)
Other	14 (7.7)
Declined/unknown	56 (30.6)
Ethnicity	
Hispanic/Latino	13 (7.1)
Not Hispanic/Latino	147 (80.3)
Declined/unknown	23 (12.6)
Living situation	
Self	17 (9.3)
Spouse or significant other	101 (55.2)
Children	12 (6.6)
Caregiver/parent/guardian	8 (4.4)
No answer/blank	45 (24.6)
Insurance	
Medicare	133 (72.6)
Blue Cross Blue Shield	35 (19.1)
Other commercial	12 (6.6)
Medicaid	3 (1.6)

Abbreviations: CBD, corticobasal ganglia degeneration; DLB, dementia with Lewy bodies; IRSP, interdisciplinary rehabilitation screening program; MSA, multiple system atrophy; PSP, progressive supranuclear palsy.

across locations.^{18,19} There was also low (n=3) referral to home health therapy, which is most likely because of the higher level mobility capabilities of this cohort referred to the interdisciplinary rehabilitation screening program. Higher levels of mobility make it difficult to justify reimbursement of the home health level of care. Additionally, low use of home health therapy in our cohort may be influenced by the availability of the more intense, comprehensive, interdisciplinary day rehabilitation setting and the absence of integrated home health services at this organization.

Although referrals to a therapy were nearly universal, 52% of those referrals attended therapy within the interdisciplinary rehabilitation hospital's system of care. This moderate rate of conversion to active participation in therapy may be because of timing of therapy participation, location of the clinics, or other barriers.^{20,21} Some interdisciplinary rehabilitation screening program participants

may have chosen to attend therapy at a later date because of to schedule or time constraints. Others may have initiated therapy services in series (eg, PT then OT) rather than in parallel because of the balance of time and energy or preference. Although the participating rehabilitation system of care has several facilities through the urban and suburban region, many people transfer to local providers if closer to home.

While these data represent only 1 academic medical center and rehabilitation hospital with expertise in PDMD, the success of this program supports the possibility for growth and sustainment of more interdisciplinary rehabilitation programs around the United States and may provide a model for achieving this. First, the growth of the program demonstrates that an interdisciplinary rehabilitation screening program model can be successful and sustainable. Second, the characteristics of people referred and screened illustrates how people with PDMD are changing over time with earlier access to rehabilitation services. Third, understanding rehabilitation utilization patterns is important in determining staffing needs for interdisciplinary rehabilitation programs in outpatient and inpatient settings. Finally, sharing programmatic data helps to improve overall understanding of aspects of interdisciplinary rehabilitation program development and evolution, including barriers and limitations related to EMR systems.

Study limitations

Limitations of this program evaluation included its retrospective design and challenges in using 2 different EMR systems (ie, matching people between 2 systems and data collected at different times, with different data fields, and for some entries, incomplete data and heavy use of free text). The clinic processes and EMR did not allow for tracking several variables, such as PD severity, therapy services received outside our hospital system, and long-term functional outcomes, which future studies will incorporate. Because the time periods compared were different sets of participants, we are not able to comment on whether the participants experienced clinical meaningful benefits from the interdisciplinary rehabilitation screening program aside from introduction to an interdisciplinary team. Data from our study reflect a single academic center in an urban location with expertise as a Parkinson's Foundation Center of Excellence, a high volume of patients with PDMD seen, and expertise of rehabilitation providers but limit the generalizability to a broader community of neurology and rehabilitation providers.^{22,23} Future research regarding this program will move beyond description of the unique, large cohort to study prospective outcomes and therapy utilization of patients referred to the interdisciplinary rehabilitation screening program.

Conclusions

We conclude that it is feasible to implement, grow, and sustain an interdisciplinary rehabilitation screening program for people with PDMD at a high-volume academic urban medical center. The screening process may be a successful method to introduce people with PDMD to the

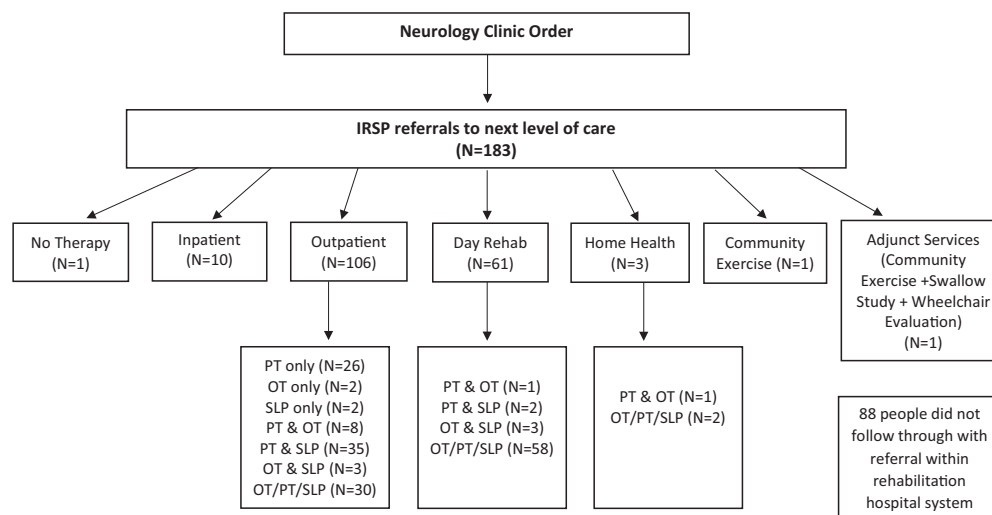


Fig 3 Referrals to allied health services from interdisciplinary rehabilitation screening program by rehabilitation setting. Abbreviation: IRSP, interdisciplinary rehabilitation screening program.

benefits of coordinated team care and to multidisciplinary or interdisciplinary rehabilitation programs not only early in their disease process but throughout all stages of disease.

Corresponding author

Uzma Khan, OTR/L, 355 E. Erie St, Chicago, IL 60611. *E-mail address:* ukhan@sralab.org.

References

1. Iannsek R. Interdisciplinary rehabilitation in Parkinson's disease. *Adv Neurol* 1999;80:555-9.
2. Davis JC. Team management of Parkinson's disease. *Am J Occup Ther* 1977;31:300-8.
3. Mitchell PH. What's in a name? Multidisciplinary, interdisciplinary, and transdisciplinary. *J Prof Nurs* 2005;21:332-4.
4. van der Marck MA, Bloem BR, Borm GF, Overeem S, Munneke M, Guttman M. Effectiveness of multidisciplinary care for Parkinson's disease: a randomized, controlled trial. *Mov Disord* 2013;28:605-11.
5. Prizer LP, Browner N. The integrative care of Parkinson's disease: a systematic review. *J Parkinsons Dis* 2012;2:79-86.
6. Goy H, Fernandes DN, Pichora-Fuller MK, van Lieshout P. Normative voice data for younger and older adults. *J Voice* 2013;27:545-55.
7. Podsiadlo D, Richardson S. The timed "Up & Go": a test of basic functional mobility for frail elderly persons. *J Am Geriatr Soc* 1991;39:142-8.
8. Keus S, Munneke M, Graziano M, et al. European physiotherapy guideline for Parkinson's disease. Available at: www.parkinsonnet.info/euguideline. Accessed March 15, 2015.
9. National Institute for Health Care and Excellence. Parkinson's disease in adults. Available at: <https://www.nice.org.uk/guidance/ng71/chapter/Recommendations#non-pharmacological-management-of-motor-and-non-motor-symptoms>. NifHaCEN-pmomanmsNGPsdia. Accessed July 19, 2017.
10. Grimes D, Gordon J, Snelgrove B, et al. Canadian guidelines on Parkinson's disease. *The Can J Neurol Sci* 2012;39(4 Suppl 4): S1-30.
11. van der Kolk NM, King LA. Effects of exercise on mobility in people with Parkinson's disease. *Mov Disord* 2013;28:1587-96.
12. Ferrazzoli D, Ortelli P, Zivi I, et al. Efficacy of intensive multidisciplinary rehabilitation in Parkinson's disease: a randomised controlled study. *J Neurol Neurosurg Psychiatry* 2018;89:828-35.
13. Kessler D, Hauteclocque J, Grimes D, Mestre T, Côté D, Liddy C. Development of the Integrated Parkinson's Care Network (IPCEN): using co-design to plan collaborative care for people with Parkinson's disease. *Qual Life Res* 2019;28:1355-64.
14. Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the timed Up & Go test. *Phys Ther* 2000;80:896-903.
15. Nocera JR, Stegemöller EL, Malaty IA, et al. Using the timed Up & Go test in a clinical setting to predict falling in Parkinson's disease. *Arch Phys Med Rehabil* 2013;94:1300-5.
16. Fullard ME, Thibault DP, Hill A, et al. Utilization of rehabilitation therapy services in Parkinson disease in the United States. *Neurology* 2017;89:1162-9.
17. Marciniak CM, Choo CM, Toledo SD, Semik PE, Aegesen AL. Do co-morbidities and cognition impact functional change and discharge needs in Parkinson disease? *Am J Phys Med Rehabil* 2011;90:272-80.
18. Frazzitta G, Bertotti G, Uccellini D, et al. Short- and long-term efficacy of intensive rehabilitation treatment on balance and gait in parkinsonian patients: a preliminary study with a 1-year followup. *Parkinsons Dis* 2013;2013:583278.
19. Nampiaparampil DE, Kuppy JE, Nampiaparampil GM, Salles SS. Inpatient rehabilitation after deep brain stimulator placement: a case series. *Parkinsonism Relat Disord* 2008;14:356-8.
20. Afshari M, Yang A, Bega D. Motivators and barriers to exercise in Parkinson's disease. *J Parkinsons Dis* 2017;7:703-11.
21. Lageman SK, Mickens MN, Cash TV. Caregiver-identified needs and barriers to care in Parkinson's disease. *Geriatr Nurs* 2015;36:197-201.
22. Keus SH, Oude Nijhuis LB, Nijkrake MJ, Bloem BR, Munneke M. Improving community healthcare for patients with Parkinson's disease: the Dutch model. *Parkinsons Dis* 2012;2012:543426.
23. Munneke M, Nijkrake MJ, Keus SH, et al. Efficacy of community-based physiotherapy networks for patients with Parkinson's disease: a cluster-randomised trial. *Lancet Neurol* 2010;9:46-54.