REVIEW

CME

Measurement Instruments to Assess Posture, Gait, and Balance in Parkinson's Disease: Critique and Recommendations

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ABSTRACT: Background: Disorders of posture, gait, and balance in Parkinson's disease (PD) are common and debilitating. This MDS-commissioned task force assessed clinimetric properties of existing rating scales, questionnaires, and timed tests that assess these features in PD.

Methods: A literature review was conducted. Identified instruments were evaluated systematically and classified as "recommended," "suggested," or "listed." Inclusion of rating scales was restricted to those that could be used readily in clinical research and practice.

Results: One rating scale was classified as "recommended" (UPDRS-derived Postural Instability and Gait Difficulty score) and 2 as "suggested" (Tinetti Balance Scale, Rating Scale for Gait Evaluation). Three scales requiring equipment (Berg Balance Scale, Mini-BESTest, Dynamic Gait Index) also fulfilled criteria for "recommended" and 2 for "suggested" (FOG score, Gait and Balance Scale). Four questionnaires were "recommended" (Freezing of Gait Questionnaire, Activities-specific Balance Confidence Scale, Falls Efficacy Scale, Survey of Activities, and Fear of Falling in the Elderly–Modified). Four tests were classified as "recommended" (6-minute and 10-m walk tests, Timed Up-and-Go, Functional Reach).

Conclusion: We identified several questionnaires that adequately assess freezing of gait and balance confidence in PD and a number of useful clinical tests. However, most clinical rating scales for gait, balance, and posture perform suboptimally or have been evaluated insufficiently. No instrument comprehensively and separately evaluates all relevant PD-specific gait characteristics with good clinimetric properties, and none provides separate balance and gait scores with adequate content validity for PD. We therefore recommend the development of such a PD-specific, easily administered, comprehensive gait and balance scale that separately assesses all relevant constructs. © 2016 International Parkinson and Movement Disorder Society

Key Words: Parkinson's disease; posture; gait; balance; rating scales

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TABLE 1. Definitions of evaluated constructs

Posture	A position in which the body is held upright against gravity, with static alignment of axial body parts in the mediolateral and anterior-posterior plane
Gait	Rhythmically alternating leg movements leading to forward movement of the body
Balance	The ability to maintain the center of gravity within the body's limits of stability, under both static and dynamic conditions, including transfers (eg, rising from a chair)
Freezing	Brief episodes during which a subject is unable to generate effective stepping movements
Falling	Any event that causes the subject to land involuntarily at a lower surface

Disorders of posture, gait, and balance are common and debilitating in patients with Parkinson's disease (PD) and even more so in atypical parkinsonism.[1,2] These axial features cause significant disability resulting from falls, immobility, and loss of independence. Adequate and timely recognition of balance and gait disorders is important to identify patients at risk of falling. Also, quantifying gait and balance deficits is relevant for monitoring patients over time.[3] Various tests and rating scales have been used with variable success to assess gait and balance disorders in PD, but there is no consensus about which screening tools are preferred or which outcomes are most suitable for monitoring. Furthermore, results are difficult to interpret because of variations in test delivery across clinicians and because scoring is subjective.[4-6]

The Movement Disorder Society (MDS) Task Force on Rating Scales commissioned a critique of existing clinical rating scales and questionnaires used in PD, aiming to place them in a clinical and clinimetric context, similar to prior efforts.[7,8] We here evaluate all measurement instruments used for assessment of posture, gait, and balance in PD and make recommendations on their utilization and the need for modifications or replacement. Our focus is on questionnaires, tests (eg, functional reach), and rating scales that do not require extra tools for administration. However, information on all instruments (ie, also rating scales requiring extra tools) is provided in the tables. A detailed assessment of all instruments is offered in the Supplemental Material.

Methods

Administrative Organization

The chairman (B.R.B.) invited professionals with diverse expertise (3 neurologists, 2 physiotherapists, 1 movement scientist, 1 epidemiologist) to participate. This task force followed the same methods as previous task forces.[9,10] The members selected instruments to be included, evaluated their clinical and clinimetric properties, and identified unresolved issues and limitations. The template used previously to assess other rating scales was adapted for reviewing posture, gait, and balance instruments and allowed for structured assessment of descriptive properties, availability, content, use, acceptability, clinimetric properties, and overall impression for use in PD (S1). We did not differentiate between screening and rating scales, as gradually increasing impairment of posture and gait are integral parts of PD; differentiation of presence versus absence of these features is unlikely to be useful. Each instrument was reviewed by 1 task force member. The completed templates were reviewed first by one other member and modified as requested and subsequently by the other members. In the final appraisal of each scale, the task force used the common terminology developed earlier.[7] The final assessment was based on consensus among task force members and the Steering Committee of the Task Force on Rating Scales for PD.

Selection of Instruments

Articles were eligible if they reported on the use and/or clinimetric aspects of instruments that clinically evaluated posture, gait, or balance in PD. We included measures of freezing of gait (FOG) and falling, as these features are closely related to the constructs assessed here (see Table 1 for definitions of examined features).

Types of instruments eligible for inclusion were rating scales and questionnaires. We also included clinically based tests that measure posture, gait, and balance. Although not rating scales, these can provide important information on severity of gait and balance impairment.

In the present article, we focus on instruments that can easily be applied in a clinical and research setting, whereas information on scales for which additional equipment is required is presented in the Supplemental Material. Information on instruments appraised as "listed" is also given in the Supplemental Material.

Appraisal of Instruments

An instrument was considered "recommended" if: (1) it had been applied to PD populations, (2) there were data on its use in clinical studies beyond the group that developed the instrument, and (3) it had been studied psychometrically in PD and found valid, reliable, and responsive. An instrument was considered "suggested" if it had been applied to PD populations, but only 1 other criterion applied. An instrument was considered "listed" if it had been applied to PD populations, but the other 2 criteria were not met or if it had been used rarely ($\leq$2 studies).[10]

Clinimetric Evaluations

The clinimetric characteristics to evaluate instruments followed the COSMIN guidelines,[11,12] with 2 additional considerations. First, content or face validity was evaluated from the perspective of the scale's purpose, that is, content validity was considered adequate if it covered the domain it intended to measure. However, when applied in PD, some scales may not adequately and comprehensively reflect the intended construct from a PD perspective, that is, it may not cover all relevant PD-specific aspects. Second, we investigated if information on the minimal clinically important difference (MCID) was available. The MCID is the smallest change in the scale's units needed for this change to be considered clinically meaningful.[13]

Literature Search Strategy

A search string including terms relating to PD, clinimetric characteristics, measurement instruments, posture, gait, FOG, balance, and falls (S2) was performed in PubMed, EMBASE, Web of Science, Cochrane, and PsycInfo by a librarian who specializes in information retrieval (last search, January 1, 2015). After removing duplicates, 1391 unique titles remained, which were screened by 1 member (J.M.). Abstracts of relevant articles and, if necessary, methods sections or full texts were then studied to identify potentially relevant instruments. Subsequently, all authors applied the same search string combined with names of instruments assigned to them. The search was limited to articles in English.

Results

Results are presented separately for the different types of instruments. Instruments requiring additional equipment are discussed in the Supplemental Material (S3).

Rating Scales

We found 11 rating scales. Although not an official rating scale, we also included the UPDRS Postural Instability and Gait Difficulty (PIGD) score and the revised MDS-UPDRS version, resulting in a total of 12 rating scales. Three scales fulfilled criteria for "recommended" or "suggested" scales and are discussed below: the PIGD score ("recommended") and the Rating Scale for Gait Evaluation (RSGE) and the Tinetti Balance Scale (both "suggested"; Tables 2A).

Postural Instability and Gait Difficulty Score (PIGD)

The original PIGD score was a component of a ratio used to distinguish among PD subtypes.[14] The score is based on 5 UPDRS items relevant to gait and postural instability (items 13-15, 29, and 30). It ranges from 0 to 20, with higher scores reflecting greater PIGD severity. Although occasionally other items have been included in this score (eg, axial rigidity), the original PIGD score (ie, comprising UPDRS items 13, 14, 15, 29, and 30) is discussed here. The PIGD score of the UPDRS has been used widely for the classification of subtypes and less frequently as outcome. The PIGD score of the MDS-UPDRS[15] is based on items 2.12-2.13 and 3.10-3.12. This score displayed very strong agreement with the PIGD score based on the UPDRS.[16]

Clinimetric Properties

The UPDRS-derived PIGD score displays a floor effect in mild PD.[17] Its internal consistency is good,[18] whereas interrater reliability of the constituent items is moderate to good.[19] The PIGD score of the UPDRS and MDS-UPDRS have adequate face validity, but only address some aspects of parkinsonian gait and balance and lack others. For example, the PIGD score does not include an adequate rating of freezing of gait, does not include tandem gait performance, and misses details on the range of postural deficits. Construct validity of both the UPDRS-based[18] and MDS-UPDRS-based[20] scores is adequate. The UPDRS-based PIGD score showed significant mean effect sizes in effect studies (Table 5, S3).[21,22]

Strengths and Weaknesses

The PIGD scores of both the UPDRS and MDS-UPDRS are suitable for discriminating between PD subtypes Sensitivity to change is relatively low. Floor effects make the score less suitable as an outcome measure in patients with mild disease.

Final Appraisal

The UPDRS-derived PIGD score fulfills the criteria for a "recommended" scale: it has been used in PD, was evaluated independently, and has adequate clinimetric characteristics. Use of the original PIGD score is recommended. However, only a few aspects of gait and balance are addressed. The MDS-UPDRS-based PIGD score was developed only recently and has undergone less clinimetric testing. Although its performance is likely similar to the original PIGD score, it is currently appraised as "listed" because it has not been evaluated independently, and data on test-retest reliability and responsiveness are lacking.

Rating Scale for Gait Evaluation

The developers of the Rating Scale for Gait Evaluation (RSGE)[23] recommend using version 2.1[24]), which contains 21 items grouped in 4 subscales (functional ability, long-term complications, socioeconomic

TABLE 2. Overview of rating scales

Instrument Name	Tapped Domain(s)	Items	Time (minutes)	Accessories	Evaluation	Strengths	Weaknesses	Limitations of Research to Date
2A – RATING SC SCALES THAT DO NOT REQUIRE EXTRA ACCESSORIES								
DYPAGS	Episodic gait disturbances	8	4–8	None	Listed	Short scale to assess dynamic aspects of gait, including freezing.	Content validity unclear. Little experience with this instrument.	Responsiveness unknown.
PIGD score	Postural stability and gait	5	5	None	Recommended	Items are part of (MDS) UPDRS and do not require extra work. Used as outcome measure of gait/balance difficulties and as measure to identify subtypes.	Postural stability and gait addressed in a restricted way.	MCID unknown. Not clear which aspects of PIGD score are sensitive to change.
RAPID	Postural instability	14	5	None	Listed	Quick and easy scale to evaluate postural instability in PD.	Content validity questionable.	Reliability and responsiveness unknown.
RSGE	Gait, posture, balance	21	10	None	Suggested	Evaluates various aspects of gait disturbances in PD. Good clinimetric properties.	Not a pure measure of gait. Anchors in response options not always clear. Responsiveness only partly established.	MCID unknown and responsiveness not fully established.
Tinetti Balance Scale	Gait and balance	16	<5	None	Suggested	Good content validity. Short administration time. Separate balance and gait scores.	Limited data on clinimetrics in PD. Floor effects in advanced PD. Not sensitive to change.	MCID unknown. No information on reliability of subscales or items in PD.
2B – RATING SC SCALES THAT REQUIRE EXTRA ACCESSORIES								
Berg Balance Scale	Static balance	14	15–20	Many[b]	Recommended	Well-validated scale of static balance.	Largely ignores dynamic aspects of balance.	MCID unknown.
BESTest	Gait, stability, posture	36	20–40	Many[c]	Suggested	Comprehensive scale with good face validity.	Lengthy (20–40 minutes). Extra material needed.	Responsiveness unknown.
Mini-BESTest[a]	Gait, stability, posture	14	10–15	Many[d]	Recommended	Good alternative for the BESTest, as it is shorter and takes only 10–15 minutes. to complete	None	Responsiveness not yet examined in a purely PD population.
Dynamic Gait Index/	Balance during walking	8		2 obstacles, staircase, shoe-box, walkway	Recommended	Well-validated scale to assess dynamic balance during gait.	None.	MCID unknown.
Functional Gait Assessment[a]	Balance during walking	10		2 obstacles, staircase, shoe-box, walkway	Recommended	Well-validated scale to assess dynamic balance during gait.	None.	MCID unknown.
FOG score	Freezing of gait	12	<15	Chair, doorway, tray	Suggested	Recently developed, promising scale with good content validity.	Some extra material needed; takes ~15 minutes to complete.	MCID unknown, data on responsiveness somewhat limited.
Gait and Balance Scale	Gait and balance	28	long	Chair, ruler, stopwatch, foam	Suggested	Comprehensive scale for assessing gait, FOG, gait cycle, balance, and posture.	Lengthy. Not all items specific to PD. Not often used. Limited independent validation.	Internal consistency and interrater reliability unknown.
Lindop scale	Stability, gait, bed mobility	10	10	Chair, bed	Listed	Separate scores for bed mobility and gait/stability.	No independent testing. Limited clinimetric data.	Validity and responsiveness largely unknown.
Trunk Impairment Scale	Sitting balance	17	15–20	Bed or table	Listed	Measures trunk movement and postural impairment in sitting; of potential value as rehabilitation measure in PD.	Quite time-consuming (18 minutes). Infrequently used thus far.	Limited data on validity in PD; no data on reliability and responsiveness in PD.

[a]Modifications of BESTest and Dynamic Gait Index, respectively.
[b]Stopwatch, measuring tape, chair, item to pick from floor, stepping stool.
[c]Table for sitting, a meter stick, a step stool, 2 weights, a foam block, a ramp, an obstacle, a stopwatch, and a 6-m walkway to complete.
[d]Foam block, chair, ramp, obstacle, stopwatch, and a 6-m walkway.

conditions and examination). The scale has been used in at least 5 PD studies.[23-27] It is administered by a clinician and available in Spanish and English.

Clinimetric Properties

No floor or ceiling effects were found.[24] Internal consistency of the total scale is high; item-total correlations of separate items ranged from 0.39 to 0.84. Interrater reliability of items (kappa) ranged from 0.54 to 1.00.[23] Construct validity is supported by high correlations of the total scale with other scales (eg, Barthel Index, UPDRS)[23,24] and timed tests.[23] Four factors were identified[23]; they did not fully support the prespecified subscales, but were retained for clinical reasons. Responsiveness has only been established for subscales 1 and 3.[27] The SDC (calculated from data in)[24] is 1.5-3.7 for subscales and 6.7 for the total scale.

Strengths and Weaknesses

The RSGE is a valid and reliable scale. Anchors in response options are not always clear (eg, item 11: "Economy"). The scale was developed in 1997 and misses recent recommendations on assessment of FOG. Given that information is elicited in different ways (interview versus examination) and that some subscales are less intuitive than others (eg, socioeconomic consequences), we recommend using subscale scores rather than the total score.

Final Appraisal

The RSGE fulfills the criteria for a suggested scale; it has been used in PD, and there are data beyond the developer's group, but its clinimetric properties have not been fully established.

Tinetti Balance Scale

The Tinetti Balance Scale is known under different names, and slightly different versions exist. Here, we discuss the variant described by Kegelmeyer[28] based on the original article.[29] There are 2 subscales: balance tests (9 items; range, 0-16) and gait tests (7 items; range, 0-12). Higher scores reflect better performance.[30]

Clinimetric Properties

Clinimetric properties have been assessed infrequently in PD, and only in mild to moderate disease.[28,31] Floor effects may occur in advanced PD.[28] Good intrarater and interrater reliability have been reported for the total score in PD,[28] but there are no data on internal consistency. Face validity is good. Sensitivity and specificity to discriminate between fallers and nonfallers are not particularly high,[28] but convergent validity with the UPDRS motor score is good, whereas moderate to strong correlations with gait speed and other balance tests were found.[28] Responsiveness has not been demonstrated in PD[31] nor in community-dwelling elderly.[32]

Strengths and Weaknesses

The Tinetti is a widely used instrument with good content and construct validity. It has separate balance and gait scores and can be administered in <5 minutes. Drawbacks are that reliability of subscores has not been evaluated in PD and the lack of responsiveness. This scale was developed for generic use in an elderly population and therefore lacks items relevant to PD (eg, more trunk sway equals poorer performance, whereas this may not be the case for patients with axial rigidity and hypokinesia). Other PD-specific items (eg, reduced arm swing) are not scored.

Final Appraisal

The Tinetti fulfills the criteria for a "suggested" scale: it has been used in PD and evaluated independently, but its clinimetrics in PD have not been studied well, and the scale has been shown not to be responsive.

Questionnaires

We identified 6 questionnaires, 1 that evaluated FOG (Freezing of Gait Questionnaire [FOGQ]), 3 that addressed fear of falling (Activities-specific Balance Confidence scale [ABC], Falls Efficacy Scale [FES], Fear of Falling Measure [FFM]), 1 that measured activity restriction because of fear of falling (modified version of the Survey of Activities and Fear of Falling in the Elderly [SAFFE-m]), and 1 that assessed difficulties walking (Generic Walking Scale [Walk-12G]). The FOGQ, ABC, FES, and SAFFE-m were classified as "recommended" and are discussed below (Table 3); the FFM and Walk-12G were "listed" because they have been evaluated insufficiently in PD.

Freezing of Gait Questionnaire

The Freezing of Gait Questionnaire (FOGQ) was developed to provide an overall assessment of gait difficulties related to FOG.[33] This 6-item scale (range, 0-24) is administered by an interviewer. Subjects rate the severity of their gait difficulties (2 items) and frequency/duration of their most typical FOG episodes (4 items) on a 5-point scale. Several modified versions exist (S3).[34,35]

Clinimetric Properties

No floor or ceiling effects were found. The scale demonstrated high internal consistency[33,34,36] and good inter- and intrarater reliability.[36,37] Content

TABLE 3. Overview of questionnaires

Instrument Name	Tapped Domain(s)	Items	Time (minutes)	Evaluation	Strengths	Weaknesses	Limitations of Research to Date
ABC scale	Balance confidence	16	5–20	Recommended	Short scale on balance confidence with good clinimetric properties.	Some items culture specific (icy sidewalks, escalators). Confidence may fluctuate with medication status.	MCID unknown.
Falls Efficacy Scale	Fear of falling	10	5	Recommended	Short measure to evaluate self-efficacy to avoid falls during ADL.	Potential floor effects in early PD; social activities not addressed. Ratings may fluctuate with medication status.	MCID unknown.
Fear of Falling Measure	Fear of falling	16	5–10	Listed	Well-developed scale that measures worry about falling in common situations.	Infrequently used (although around >10 years).	Retest reliability and responsiveness unknown.
Freezing of Gait Questionnaire	Freezing of gait	6	5	Recommended	Useful as a screening tool and descriptor of FOG and gait disorder.	Two of 6 items do not address freezing but gait; thus, nonfreezers can get a score > 0. Responsiveness limited.	MCID unknown.
New Freezing of Gait QywaruibbUEW		9	8	Suggested	Useful as a screening tool and measure of FOG.	Responsiveness insufficiently examined.	MCID unknown.
Generic Walking Scale	Walking difficulties	12	3.5	Listed	Short self-report measure to assess walking difficulties in everyday life.	This is a generic scale; items specific to PD are lacking.[a] Hardly been used in PD.	Responsiveness in PD unknown.
SAFFE-m	Activity avoidance because of fear of falling	17	~10	Recommended	Self-report measure of acceptable length; asks if patients would avoid certain activities in case they fell over.	No apparent disadvantages.	Limited data on responsiveness. MCID unknown.

[a]Measurements complicated by freezing of gait.
ABC, Activities-specific Balance Confidence Scale; SAFFE-m, Survey of Activities and Fear of Falling in the Elderly–Modified.

validity is good,[33] and criterion validity is supported by the ability to discriminate freezers from nonfreezers as identified by item 14 ("freezing when walking") of the UPDRS-Activities of Daily Living scale (ADL).[34,36] Construct validity is supported by the 1-dimensional structure[33,36] and high correlations with other gait and balance measures. The FOGQ is sensitive to change.[38-40]

Strengths and Weaknesses

The FOGQ is a short, reliable, and valid instrument that is easy to use and can be used as an outcome measure. A drawback is that it includes 2 gait items, implying that it is not a pure measure of freezing because nonfreezers can get nonzero scores. Another potential drawback is that it relies on self-report as opposed to objective ratings.

Final Appraisal

The FOGQ fulfills the criteria for a "recommended" scale; it has been used in PD and was evaluated independently, demonstrating good clinimetric characteristics.

Activities-Specific Balance Confidence (ABC) Scale

The ABC was developed from the FES (see below), but includes more items (16 versus 10) that are phrased more situation-specifically.[41] Respondents indicate their level of confidence in doing activities without losing balance.[41] Response options range from 0% (no confidence) to 100% (completely confident). The scale is available in US and UK English, Canadian French, German, Turkish, Dutch, Icelandic, Spanish, and Chinese.

Clinimetric Properties

We found no evidence of floor or ceiling effects. Internal consistency[42,43] and test-retest reliability[43] in PD are very good. Content validity is adequate. The scale discriminates between fallers and nonfallers in PD. Construct validity is supported by moderate to strong correlations with gait and balance (confidence) measures.[44-46] The minimal detectable change (MDC) — which indicates that a change is "real," that is, larger than the measurement error — is 13%.[43]

Strengths and Weaknesses

The scale has been used widely in PD. The items are easy to understand. Although content validity is generally good, some items (eg, icy pavements, use escalator) may not be relevant in all populations.

Final Appraisal

The ABC fulfills the criteria for a "recommended" scale; it has been used in PD, was evaluated independently, and has adequate clinimetric characteristics in PD.

Falls Efficacy Scale (FES)

The FES evaluates how confident subjects are in performing a particular activity without falling. The scale has 10 items and is administered by an interviewer.[47] Response options range from 0 (not at all confident) to 10 (completely confident).[47] Multiple modified versions exist (S3).[48] The scale is available in US and UK English, Persian, Swedish, Serbian, Greek, Brazilian Portuguese, and Italian.

Clinimetric Properties

Floor and ceiling effects in PD are acceptable.[49] Internal consistency and test-retest reliability in PD was high in a 13-item Swedish version.[49] Content validity seems adequate. In PD the FES correlated significantly with the FOGQ[35,50] and SAFFE-m.[49] The standard error of measurement in PD is 12.3.[49]

Strengths and Weaknesses

The FES is a short, well-validated measure with items that are easy to understand. A potential disadvantage is that social activities are not addressed.

Final Appraisal

The FES fulfills the criteria for a "recommended" scale; it has been evaluated independently and used broadly in PD, with satisfactory clinimetric properties.

Survey of Activities and Fear of Falling in the Elderly–Modified (SAFFE-m)

The SAFFE-m[51] was developed from the "worry" subscale of the SAFFE.[51,52] It contains 17 items. Patients are asked whether they would avoid each activity in case they fell over on a 3-point scale, ranging from 0 (never avoid) to 2 (always avoid). The SAFFE-m is available in English, Swedish, and Dutch.[49,51,53]

Clinimetric Properties

Data completeness is very satisfactory.[46] Internal consistency in PD is high, whereas test-retest reliability (intraclass correlation coefficient [ICC]) over 1- to 3-week intervals is good.[46,49] Content validity appears adequate, whereas construct validity is supported by moderate correlations with the Timed Up-and-Go test and UPDRS sections II and III,[49] and strong correlations are found with fall-related measures.[46]

Responsiveness was demonstrated by significant improvements after deep brain stimulation.[54]

Strengths and Weaknesses

The SAFFE-m is a self-administered instrument of acceptable length with good clinimetric characteristics.

Final Appraisal

The SAFFE-m fulfills the criteria for a "recommended" scale: it has been used in PD, there are data beyond the developers, and the instrument is reliable, valid, and responsive.

Other Scales

Two other scales that did not require additional equipment were appraised as "listed" because they were used only once by the developers and insufficient clinimetric support was found (Dynamic Parkinson Gait Scale; Rapid Assessment of Postural Instability in PD; Table 2A, S3). Of 7 additional scales whose administration requires equipment, 3 were "recommended"(Berg Balance Scale, Mini-BESTest, Dynamic Gait Index/Functional Gait Assessment), 2 were "suggested" (FOG score, Gait and Balance Scale), and 2 were "listed" (Lindop Mobility Assessment, Trunk Impairment Scale; Table 2B).

Clinically Based Tests

Four clinically based tests for which the outcome was measured in time or distance were identified: 6-minute walk, 10-m walk, functional reach, and Timed Up-and-Go (Table 4, S3).

6-Minute Walk Test

In the 6-minute walk test (6-MWT)[55] the participant is asked to cover as much ground as possible on a standardized walkway (typically 33 m). Use of assistive devices is allowed, and subjects are permitted to stop if necessary.

Clinimetric properties

As a timed test, there are no ceiling effects, but it can only be applied to patients who are able to walk. Learning effects may occur.[56] The 6-MWT demonstrated adequate test-retest and interrater reliability in PD with ICCs ranging from 0.88 to 0.95.[56,57] Test scores correlated weakly with the UPDRS motor subsection and moderately to strongly with the Berg Balance Scale, 10-MWT,[58] and Timed Up-and-Go (TUG)[59] and may be a good predictor of a subject's ability to independently walk outside safely. Responsiveness in PD has been demonstrated. An MDC of 82 m has been reported.[43]

Strengths and weaknesses

The test is easy to administer and may be useful for identifying improvement in gait endurance following therapeutic interventions, but is only useful in mild to moderate patients. Although intended to measure walk endurance, performance in PD may depend on the presence of freezing and turning difficulties.

Final appraisal

The 6-MWT fulfills the criteria of a recommended test because it has been used in PD by independent groups, demonstrating good clinimetric characteristics.

10-m Walk Test (10-MWT)

In the 10-MWT subjects are asked to walk at either their self-selected or maximal speed over a 10-m course. Timing is typically performed over the middle 6 m.

Clinimetric properties

Test-retest reliability in non-PD and PD is generally moderate to high, with ICCs ranging from 0.75 to 0.98.[58,60-62] Gait speed accurately predicted fall risk in PD patients.[63,64] Construct validity has been assessed, showing low to moderate correlations with balance tests, whereas associations with measures of disease severity (UPDRS subscales) have generally been low.[65] Responsiveness in PD was established by significant differences between pre- and postintervention scores following rehabilitation and deep brain stimulation.[66-71] The MDC in PD ranged between 0.02-0.18 and 0.09-0.25 m/s for preferred and maximal gait speed, respectively.[43,58,72] The MCID (determined in non-PD) ranged from 0.10 to 0.16 m/s.[73,74]

Strengths and weaknesses

The test is easy to administer and may be useful for identifying changes in gait speed over time in mild to moderate PD. The presence of freezing may affect the outcome.

Final appraisal

The 10-MWT fulfills the criteria of a recommended test because it has been used in PD by independent groups, displaying good clinimetric properties.

Functional Reach Test

The Functional Reach Test (FRT) was developed to assess balance.[75] It can be administered in subjects who can stand 1 minute without support. A ruler is mounted on the wall at shoulder height, and the subject is asked to reach as far forward as possible with the arm outstretched; the difference in centimeters

TABLE 4. Overview of clinical tests

Instrument Name	Tapped Domain(s)	Time (minutes)	Accessories	Evaluation	Strengths	Weaknesses	Limitations of Research to Date
6-Minute walk test	Gait speed and endurance	<10	33-m walkway	Recommended	Simple and short measure of gait and endurance.	Many aspects of PD gait not measured; repeated turns and cardiovascular fitness may affect distance covered in PD.[a]	MCID unknown.
10-m Walk test	Gait speed	5	Stopwatch, 10-m walkway	Recommended	Simple, short mea-sure of gait speed.	None.[a]	None
Functional Reach Test	Balance	<5	Ruler on wall	Recommended	Quick and easy test to determine margins of stability.	Accuracy in predicting falls uncertain, although this was the purpose of this measure.	MCID unknown.
Timed Up-and-Go test	Rising, gait, turning	5	Watch, chair, 3-m walkway	Recommended	Very representative tool for PD.	Not good for people who must use walking aids; potential influence of weight/size.[a]	MCID unknown.

[a]Measurements complicated by freezing of gait.

with the initial (upright) position is recorded as outcome. Alternate forms exist (S3).

Clinimetric properties

Test-retest reliability in PD (calculated as ICC) was 0.84 for a testing interval of 1 day[57] and 0.73-0.74 for 1 week.[43,76] FRT scores were significantly associated with center of pressure excursions.[75] Criterion validity to predict falls has not been convincingly demonstrated[77]; some studies found score differences between fallers and nonfallers,[78-80] whereas others did not.[81,82] In PD moderate (0.44-0.51) to strong (0.72-0.76) correlations were shown with balance master items[83] and reaching tasks.[84] Responsiveness in PD has been demonstrated by significant differences in scores between exercise and control groups.[57,85] The MDC was calculated at 11.5 cm.[76]

Strengths and weaknesses

The FRT is a practical, reliable, and valid tool that can be used to evaluate the effect of interventions; its ability to predict falls in PD is uncertain.

Final appraisal

The FRT fulfills the criteria for a recommended test. It has been used in PD, there are data beyond the developers and clinimetric characteristics in PD are adequate.

Timed Up-and-Go

The participant is required to get up from a standard chair, walk at a comfortable and safe speed to a line 3 m away, then turn at the line and walk back to the chair to sit down.[86] Use of assistive devices is allowed.

Clinimetric properties

No ceiling effects exist,[87] but there are floor effects at scores of 10[88] to 15[43] seconds. The TUG demonstrated adequate test-retest and inter-rater reliability in PD, with ICCs ranging from 0.80 to 0.99.[43,89,90] A score > 7.95 seconds may indicate a high risk for falling.[91] Known-group validity in PD has been demonstrated by the test's ability to discriminate between early and middle disease stages,[20,92,93] postural instability–gait difficulty dominant, and tremor-dominant types of PD,[94] and fallers and nonfallers.[95] Construct validity in PD was demonstrated by correlations with walking speed, stride length, and turning ability.[96] Responsiveness in PD has been demonstrated by significant differences between pre- and postintervention scores in physical[91,97-99] and surgical[100] intervention studies and by the test's sensitivity to dopaminergic medication.[90] Absolute MDC values in PD varied from 3.5[101] to 11[43] seconds, whereas relative changes greater than 29.8% may reflect "true" change.[101]

Strengths and weaknesses

The test is easy to administer and may be useful for evaluating effects of interventions, but is limited to those who are not wheelchair bound.

Final appraisal

The TUG fulfills the criteria of a recommended test: it has been used and evaluated in PD by independent groups, where clinimetric properties were satisfactory.

TABLE 5. Psychometric data of all instruments used in PD

	Floor/Ceiling	Internal Consistency	Retest Reliability[a]	Content Validity	Construct Validity	Responsiveness	MCID
6-Minute walk test	No	NA	+	NE	+	+	−
10-m Walk test	No	NA	+	NE	+	+	+
Activities-specific Balance Confidence Scale	No	+	+	+	+	+	−
Berg Balance Scale	Ceiling in early	+	+	+	+	+	−
Balance Evaluation Systems Test (BESTest)	No	NE	+	+	+	−	−
Mini-BESTest	No	+	+	+	+	+	+
Dynamic Gait Index	Ceiling in early	NE	+	+	+	+	−
Functional Gait Assessment	Ceiling in early	NE	+	+	+	+	−
Dynamic Parkinson's Gait Scale	No	+	+	±	+	−	−
Falls Efficacy Scale	No	+	+	+	+	+	−
Fear of Falling Measure	No	+	NE	+	+	NE	−
FOG score	Floor in early PD	+	+	+	+	+	−
Freezing of Gait Questionnaire	No	+	+	+	+	+	−
New Freezing of Gait Questionnaire	No	+	+	+	+	+	−
Functional Reach Test	No	NA	+	+	+	+	−
Gait and Balance Scale	Unknown	NE	±	+	+	+	−
Generic Walking Scale	No	+	+	±	+	−	−
Lindop PD Mobility Assessment	Ceiling in early	+	+	+	±	NE	−
Postural Instability Gait Dysfunction (UPDRS)	Floor in early PD	+	+	+	+	±	−
Rapid assessment of postural instability in PD	NA (screening)	NE	NE	±	±	NA	NA
Rating Scale for Gait Evaluation	No	+	+	±	+	±	−
Survey of Activities and Fear of Falling in the Elderly–Modified	No	+	+	+	+	+	−
Timed Up-and-Go test	No	NA	+	NE	+	+	−
Tinetti Balance Scale	Floor in advanced	NE	+	+	+	−	−
Trunk Impairment Scale	Ceiling subscales	+	+	+	+	−	−

NA, not applicable; NE, not examined; early, early disease; advanced, advanced disease; +, good/adequate; ±, performance is questionable/mediocre; -, performance is insufficient or information is not available or incomplete.
[a]Retest reliability may involve intrarater reliability, interrater reliability, or test-retest reliability; for detailed information see Supplement 3.

Discussion

Rating Scales

Among the identified rating scales, only the PIGD was considered "recommended," whereas the RSGE and Tinetti Scale were qualified as "suggested." However, all assessed rating scales had limitations. Most scales do not include insights into the best clinical assessment of FOG,[102,103] which is now regarded as a leading cause of falls in PD. Instructions for specific test delivery vary between different scales and often lack sufficient detail for unambiguous, standardized performance as well as test interpretation by different examiners. In addition, some scales primarily address non-PD-specific constructs, such as static balance or generic aspects of gait, but ignore PD-specific features such as shuffling, festination, or reduced arm swing. Even among scales that require extra accessories (see S3), none assesses all relevant PD-specific features of gait. Conversely, other scales comprehensively assess only one specific aspect of PD-related gait, such as FOG. The rating scales that do contain items on (parkinsonian) gait, postural (in)stability, and freezing assess a broad range of concepts, but do not allow for separate evaluation of the individual constructs (such as gait or balance). At present, it is therefore difficult to select a suitable instrument with good clinimetric properties in PD and with sufficient detail for use in future studies. For example, although the PIGD score of the UPDRS is "recommended," it consists of a mix of observer-based information on postural stability and gait and interview-based information on walking, freezing, and falling, not allowing separation of these distinctive concepts. In addition, it lacks sufficient detail for nuanced assessment of gait and balance assessment in PD, particularly with respect to early disease. More work is therefore needed, in particular to develop a comprehensive PD-specific gait scale that includes separate sections on gait and FOG and for which both subscores and a total score can be used. In addition, such a scale should capture the complex spectrum of balance abnormities (both static and dynamic) and the various changes in axial alignment (including Pisa syndrome and camptocormia).[104] Development of unambiguous descriptions of standardized scale delivery and interpretation will be mandatory.

Pending further evidence, the task force recommends using the PIGD score as a clinical rating scale and suggests considering the additional use of the RSGE or Tinetti Scale (Table 2). If scales that require some office equipment such as a staircase, chair, or

obstacles are considered, the Berg, the Mini-BESTest, and the Dynamic Gait Index/Functional Gait Assessment are recommended options that address a broad range of constructs, although a disadvantage is that these scales lack items that are specific to PD.

Questionnaires

Four of the 6 identified questionnaires were rated as "recommended" (FOGQ, ABC, FES, SAFFE-m), whereas 2 others (FFM, Walk-12G) were "listed" because they were used in less than 3 studies published in English. For freezing, our analysis identified the FOGQ as a recommended questionnaire that can be used to evaluate FOG frequency and severity at home,[33] but it combines assessment of FOG and gait. The new version of this scale (NFOGQ; S3) assesses FOG only[34] but has been insufficiently tested. Objective assessment of FOG, such as instructing patients to make fast 360° turns in both directions[105,106] or using the FOG score, in which patients are asked to perform a series of motor tasks on a standardized course,[107] also need further clinimetric testing.

The ABC and FES assess confidence in maintaining balance while performing activities. These measures are not actual measures of balance control because results may be influenced by factors other than balance; for example, both overestimation (as in fall phobia) and underestimation (as in reckless gait) may occur. The SAFFE-m evaluates whether people would avoid certain activities to prevent falls. Clinicians must therefore first decide whether fear of falling or activity avoidance because of fear of falling is the construct of interest. For fear of falling the choice between ABC and FES is difficult because the constructs are similar, as the ABC was developed from the FES, and both displayed good clinimetric characteristics in PD. The ABC includes items relating to social activities (unlike the FES) and is a self-report measure (whereas the FES is administered by an examiner).

As the 4 recommended questionnaires focus on different components of the multidimensional issues of PD-related gait/balance/posture deficits, they may need to be used together rather than independently. With respect to the balance confidence measures, patients should be instructed to rate their average fear of falls because ratings may fluctuate based on medication status. There is also no PD-specific questionnaire on community ambulation (ie, the ability for patients to move about freely in their own natural environment).

Clinical Tests

Four tests — 6-MWT, 10-MWT, FRT, and TUG — have been used broadly in PD and were all considered "recommended," Their limitations for use in PD should be taken into account because the outcome may be affected by various disease-specific features (eg, freezing affects the 10-MWT). From a PD perspective, these tests therefore have limited content validity.

Future Recommendations

We found no scale suitable for all clinical purposes to assess gait, balance, and posture, as none of the instruments adequately and separately assesses all constructs, that is, gait (including FOG), balance, and posture. It is also unlikely that a single unidimensional scale can be developed for all 3 constructs (gait, balance, and posture) because of the potential heterogeneity in underlying pathophysiology. Given that these concepts are interrelated but independent constructs, it is recommended to assess them simultaneously, but to ensure that separate scores are obtained for the constructs. An ideal future scale should therefore include separate sections for gait, balance, and posture and should specifically address FOG and fear of falling.

Further issues to address in the future with all instruments discussed in this review are their sensitivity to change, information on the MCID of any instrument (lacking for all except for the 10-MWT and for the Mini-BESTest, for which extra equipment is required), and applicability across the disease spectrum, which has received little attention to date. Promising additional developments include the use of objective and automated assessments (eg, using body-worn sensors) to assist or even replace the clinical observation with more precise measures, not only for use within the clinic, but particularly also for prolonged assessments in patients' own home environments.[108,109]

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Supporting Data

Additional Supporting Information may be found in the online version of this article at the publisher's web-site.