Research Report

Reliability and Validity of the Tinetti Mobility Test for Individuals With Parkinson Disease

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Background and Purpose

This study examined the interrater and intrarater reliability, concurrent validity, and criterion validity of the Tinetti Mobility Test (TMT) as a fall risk screening tool in individuals with Parkinson disease (PD).

Subjects

Thirty individuals with PD voluntarily participated in the study, and data from a retrospective review of 126 patient records were included.

Methods

Physical therapists and physical therapist students rated live and videotaped performances of the TMT. Tinetti Mobility Test scores were correlated with Unified Parkinson's Disease Rating Scale (UPDRS) motor scores and comfortable gait speed. The ability of the TMT to accurately assess fall risk was determined.

Results

Interrater and intrarater reliability was good to excellent (intraclass correlation coefficient of >.80). Tinetti Mobility Test scores correlated with UPDRS motor scores (r_s=−.45) and gait speed (r_s=.53). The sensitivity and specificity of the TMT to identify fallers were 76% and 66%, respectively.

Discussion and Conclusion

The TMT is a reliable and valid tool for assessing the mobility status of and fall risk for individuals with PD.

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As individuals with Parkinson disease (PD) progress through Hoehn and Yahr stages 1 to 5,[1] they experience increasing postural instability and gait deviations that result in falls at a greater rate than in their age-matched peers.[2,3] Falls occur most often while turning, initiating gait after rising from a chair, and slowing to sit down.[3] The risk of limb fractures from falls is significantly higher in patients with PD compared with age-matched controls, making falls screening and prevention an important component of the clinical management of individuals with PD.[4,5]

At present, there is no general agreement among clinicians as to the most accurate tool for predicting falls in individuals with PD.[6] Previous studies[6,7] have shown that common clinical balance tests—such as the Functional Reach Test (FRT), the Timed "Up & Go" Test (TUG), the Dynamic Gait Index (DGI), and the Berg Balance Scale (BBS)—are poor predictors (sensitivity of $<$0.60) of falls in individuals with PD if cutoff scores reported in studies of elderly people are used. Dibble and Lange[6] recently recalculated the cutoff scores for these balance tests to maximize the sensitivity and positive likelihood ratios for the PD population. They reported that the BBS had the best accuracy compared with the other tests for predicting falls (sensitivity=0.79, specificity=0.74) if the cutoff score was raised to 54 out of 56. However, the spread of only 2 values between the cutoff and maximum scores makes utilization of this test problematic, because small, natural fluctuations in patient performance or therapist ratings would quickly take the person from a "no fall risk" to a "high fall risk" category. For example, a person might be highly motivated on one day to perform the step stool maneuver and complete 8 steps in 19 seconds, whereas on another day the person might be less motivated or feel less energetic and take 21 seconds, changing his or her BBS score from a 4 to a 3. Because a clinically meaningful change in function on the BBS is reported to be 5 to 7 points, there would be a ceiling effect if a cutoff score of 54 is used.[8]

Bloem et al[3] were able to predict recurrent falls using a combination of prior falls history, disease severity as measured with the Unified Parkinson's Disease Rating Scale (UPDRS), and the Romberg test with only moderate sensitivity (65%). The method of Bloem et al does not identify those at risk for falling before a fall occurs. Given the potentially serious physical and psychological complications of falls, it is imperative that individuals are identified as being at risk for falls before a fall actually occurs.

The Tinetti Performance-Oriented Mobility Assessment (POMA), also called the Tinetti Mobility Test (TMT) (Appendix), is a reliable and valid clinical test to measure balance and gait in elderly people and some patient populations.[9–20] The balance and gait subscales that form the TMT have been studied individually or combined as in this study.[8,10,11,19] The TMT predicts falls among elderly individuals[9,11,13,14]; those scoring 19 to 24 out of 28 on the TMT have a "moderate" risk for falling, and individuals scoring $<$19 have a "high" risk for falling.[21] The TMT was found to have the best predictive validity for fall risk in elderly people when compared with the TUG, FRT, and one-leg stance test.[15,21] The TMT is easily administered and provides information about an individual's ability to ambulate and transfer safely.[22,23] Tasks that reportedly most often lead to falls[24] and that predict balance confidence[25] in individuals with PD (ie, turning, initiating gait, slowing to sit down) are assessed with the TMT. Balance, gait, and total scores on the TMT discriminated between individuals with PD who were recurrent fallers ($>$1 fall reported in the past 6–12 months) and those who were not recurrent fallers better than retropulsion, tandem stance, single-limb stance, and Romberg tests.[3,26] The TMT can be administered in less than 5 minutes, making it more clinically feasible than the BBS, which takes 15 to 20 minutes to administer.

The interrater and intrarater reliability of data for the TMT and its ability to assess balance and gait impairment severity and to screen for fall risk have not been determined for individuals with PD. We were interested in determining whether the TMT is an accurate test for predicting falls in the PD population. Therefore, this study examined TMT: (1) interrater reliability during on-site testing, (2) intrarater reliability from videotaped performances, (3) concurrent validity with comfortable gait speed and UPDRS motor examination (section III) scores,[27] (4) concurrent criterion-related validity as a screening tool for fall risk in individuals with PD, and (5) cutoff scores for the purpose of determining fall risk. The reliability and validity of data for the TMT must be established in order for health care professionals to accept it as a clinical tool to identify and monitor fall risk in this population.

Method

Subjects

Thirty individuals with a diagnosis of PD (Tab. 1) who attended our Movement Disorders Clinic voluntarily participated in all parts of the study. Subjects reported that they were optimally medicated and had taken their PD medications within 1 hour of testing. Medications that the subjects reported taking were Sinemet

Table 1.
Subject Characteristics[a]

Characteristic	Parts 1–3 (n=30)	Part 4 (n=156)
Age (y), $\overline{X}$±SD	65±10.9	68.8±11.04
Sex		
Male (n)	23 (77%)	99 (63.5%)
Female (n)	7 (23%)	57 (36.5%)
Hoehn and Yahr stage, $\overline{X}$±SD	2.41±0.39	2.5 (range=1–5)
Duration (y), $\overline{X}$±SD	9.4±7.3 (range=1–28)	
UPDRS motor subscale score, $\overline{X}$±SD	26.21±9.0	
Comfortable gait speed (m/s), $\overline{X}$±SD	1.07±0.20	

[a] Part 1=interrater reliability, part 2=intrarater reliability, part 3=concurrent validity, part 4=concurrent criterion-related validity for assessing fall risk. UPDRS=Unified Parkinson's Disease Rating Scale.

(n=24),* Requip (n=9),† Mirapex (n=9),‡ amantadine (n=8), Comtan (n=2),§ Symmetrel (n=2),‖ Kemadrin (n=2),† Eldepryl (n=1),# Artane (n=1),** and Permax (n=1).††

For part 4 of this study (concurrent criterion-related validity) only, TMT scores and fall history data obtained from a retrospective review of the medical records of all patients with PD who were examined by a physical therapist during regular clinic visits (n=126) were included. During the regular clinic visit, all patients performed the UPDRS, the TMT, and a test of gait speed, and a fall history was taken. The fall history consisted of asking the patient how many times he or she fell in the last 6 months and in the last week. *Falls* were defined as unintentionally coming to rest on the ground or other surface.[26] Experienced raters 1 and 2 performed these examinations on all individuals included in the retrospective portion of the study. These 126 patients attended the clinic in the year prior to initiation of data collection. Data from these 126 patients were combined with data from the 30 recruited subjects (n=156) (Tab. 1).

Subjects were admitted to the study if they were in Hoehn and Yahr stage 1 through early stage 4[1] and were able to independently ambulate with or without the use of an assistive device. Subjects with the following criteria were excluded: (1) history of upper motor neuron lesion or disease other than PD, (2) diagnosis of vestibular disorder, (3) presence of musculoskeletal injury that prevented performance of any test maneuvers, (4) history of any brain surgery, or (5) Mini-Mental State Examination scores of <24. Subjects recruited for parts 1, 2, and 3 of the study (interrater reliability, intrarater reliability, and concurrent criterion validity) signed informed consent and videotape release forms prior to participating in the study.

Part 1: Interrater Reliability

Raters. Raters were 2 experienced physical therapists (DAK and ADK), and 3 second-year physical therapist students. All raters received instructions on scoring the TMT by a physical therapy faculty member prior to starting the study.

One of the physical therapists, designated the administering rater, instructed the subjects on how to perform the maneuvers, guarded the subjects, and scored each subject's performance. The other physical therapist and the physical therapist students were designated the observing raters (ORs); their role was to watch with a lateral view at a distance of less than 2.4 m (8 ft) from the subject and to score each subject's performance. Raters did not speak to each other during testing. This design was used to avoid changes in subject performance caused by medication fluctuations or excessive fatigue from performance of repetitive tests on a single day. Testing subjects on different days was not a viable option because of potential symptom variability across days and because of the time, expense, and physical demands required for many subjects to travel to and from a tertiary care center. This design was used previously

* Merck & Co Inc, PO Box 4 WP39-206, West Point, PA 19486-0004.
† GlaxoSmithKline, 5 Moore Dr, Research Triangle Park, NC 27709.
‡ Boehringer Ingelheim Pharmaceuticals Inc, a subsidiary of Boehringer Ingelheim Corp, 900 Ridgebury Rd, PO Box 368, Ridgefield, CT 06877-0368.
§ Novartis Pharmaceuticals Corp, One Health Plaza, East Hanover, NJ 07936.
‖ Endo Pharmaceuticals, 100 Endo Blvd, Chadds Ford, PA 19317.
\# Somerset Pharmaceuticals Inc, 3030 North Rocky Point Dr, Ste 250, Tampa, FL 33607.
** Wyeth Pharmaceuticals, Division of Wyeth, PO Box 8299, Philadelphia, PA 19101.
†† Valeant Pharmaceuticals International, 3300 Hyland Ave, Costa Mesa, CA 92626.

in a study of subjects with amyotrophic lateral sclerosis (ALS).[19]

Procedure. Subjects performed one trial of the TMT (Appendix).[9,10] Each item of the TMT is scored using a scale of 0 to 1 or 2,[9] and the total possible score on the TMT is 28 points, with higher scores indicating better performance.[9] During the middle of the gait portion of the TMT, an OR used a stopwatch to measure the time (in seconds) that it took each subject to walk a straight distance of 7.5 m (25 ft) that was clearly marked on the floor. The total distance traversed was 8.7 m (29 ft), allowing 0.6 m (2 ft) before and after timing to accommodate for acceleration and deceleration.

Testing took approximately 10 minutes. Subjects were permitted to use any assistive or orthotic device that they typically used for ambulation.[9] Subjects were instructed that they could refuse to perform any maneuver if they felt unsafe. No subject refused any maneuver.

Part 2: Intrarater Reliability

Raters. Two community physical therapists with experience treating individuals with neurological disorders (DAK and ADK) and 4 second-year physical therapist students were the raters. The raters were not the same raters who participated in part 1. All raters received training on scoring the TMT by a physical therapy faculty member prior to the study.

Procedure. Subjects were videotaped during part 1 of the study. The camera was placed approximately 1.5 to 3 m (5–10 ft) away from the subject in the frontal plane on a tripod to ensure that all parts of the test were filmed.[10] However, this placement was not optimal for viewing sagittal-plane aspects of the TMT performances such as step length, height, and symmetry, and raters may have had some difficulty rating those items. Viewer ratings of videotaped performances of subjects have been used frequently in reliability studies.[10,28–31] To determine intrarater reliability, the rater viewed and rated the videotaped test session for each of the subjects and then repeated the same process 1 week later.[32] Raters viewed each subject's taped performance only once without slowing or stopping the tape.

Part 3: Concurrent Validity

Procedure. One of the 2 experienced therapists (DAK and ADK) administered the motor examination section of the UPDRS (section III) to subjects prior to administration of the TMT. Items are graded on a scale of 0 to 4, with 0 being normal and 4 being the most severe. The reliability and validity of UPDRS scores in patients with PD have been established previously.[27,33–35]

Parts 4 and 5: Concurrent Criterion-Related Validity for Assessing Fall Risk

Administrators. Two experienced physical therapists (DAK and ADK) administered the TMT as part of their routine evaluation of patients at the Movement Disorders Clinic.

Procedure. A fall history was obtained from each subject as described previously by Behrman et al.[7] Subjects were asked if they experienced one or more falls in the past 6 months and in the past week. A *faller* was defined as a person who had experienced one or more falls during the previous 6 months or in the past week. Both the 1-week and 6-month fall data were obtained to capture changes in the fall status of individuals with PD over time. For example, some individuals who reported falling in the past 6 months had adopted fall prevention strategies (eg, use of an assistive device or a change in medications) so that they were not falling during the week prior to testing.

Data Analysis

Data were analyzed using SPSS version 13.0 software.[‡‡] For interrater and intrarater reliability, the reliability inferred from the intraclass correlation coefficent (ICC) values was classified as follows: >.85=excellent; .75–.85=good; <.75=fair.[36] Spearman rank correlation coefficients were used to determine the association among TMT scores, UPDRS motor examination scores, and gait speed measurements.[37] The criteria used to evaluate Spearman correlation coefficients were: fair (values of .25–.50), moderate to good (values of .50–.75), and excellent (values of .75 and above).[37] The required level of significance for all tests was set at $P<.05$.

Concurrent criterion-related validity of the TMT as a screening tool for fall risk in individuals with PD was determined by assessing the accuracy of the TMT falls criterion (<20) for elderly people[21] in identifying individuals with PD with a history of falls. The cutoff score of the TMT to identify an individual with PD at risk of falling was calculated based on statistical tests of sensitivity and specificity from an independent *t* test with unequal variances, as well as analysis of its area under the receiver operating characteristic (ROC) curve. The following validity measures then were calculated:

(1) test sensitivity—the ability of the TMT to obtain a positive test when the individual is truly a faller,

(2) test specificity—the ability of the TMT to obtain a negative score when the person is truly a nonfaller,

‡‡ SPSS Inc, 233 S Wacker Dr, Chicago, IL 60606.

(3) positive predictive value—the estimated probability that a person who tests positive actually has a history of falls,

(4) negative predictive value—the estimated probability that a person who tests negative actually does not have a history of falls,

(5) positive likelihood ratio—the increase in the probability of being a faller if the test is positive, and

(6) negative likelihood ratio—the decrease in probability of being a faller if the test is negative.[37]

Table 2.
Interrater Reliability of Tinetti Mobility Test Scores[a]

Rater Combinations	ICC (95% CI)
All raters (n=5)	.87 (.80–.93)
Therapist raters (n=2)	.84 (.69–.92)
Student raters (n=3)	.89 (.80–.94)
Therapist rater 1/student rater 1	.82 (.70–.90)
Therapist rater 1/student rater 2	.88 (.77–.94)
Therapist rater 1/student rater 3	.88 (.76–.94)
Therapist rater 2/student rater 1	.83 (.67–.92)
Therapist rater 2/student rater 2	.90 (.80–.95)
Therapist rater 2/student rater 3	.94 (.87–.97)

[a] ICC=intraclass correlation coefficient, CI=confidence interval.

Results

Part 1: Interrater Reliability of On-Site Raters

The mean and standard deviation of the total TMT scores for all 30 subjects were 23.25±3.75 (range=12–28). The ICCs for total TMT scores between all raters, physical therapist raters, and physical therapist student raters were good to excellent ($r \geq .80$, $P < .001$) (Tab. 2). Similar ICC values between all combinations of raters were found for the balance and gait subscales of the TMT ($r = .80$–$.86$, $P < .001$). Physical therapist student rater scores were highly correlated with physical therapist scores ($r = .82$–$.94$, $P < .001$).

Part 2: Intrarater Reliability of Videotape Raters

The mean and standard deviation of the total TMT scores for all 30 subjects were 22.52±3.74 (range=10–28). The ICCs of the total TMT scores recorded by the 6 raters on day 1 and 1 week later were moderate to high ($r = .69$–$.88$, $P < .0001$) (Tab. 3).

Part 3: Concurrent Criterion Validity

The subjects' mean score and standard deviation on the UPDRS motor subscale were 26.21±9.0 (range=8–50), and mean comfortable gait speed was 1.07±0.20 m/s (range=0.54 m/s–1.46 m/s). Total TMT scores for the 30 subjects had a significant and fair negative correlation with UPDRS motor examination (section III) scores (Tab. 4) and a moderate to good positive correlation with comfortable gait speed, indicating that higher TMT scores were associated with a lower severity of motor impairments and a higher gait speed. The balance and gait subscale scores were similarly correlated with the UPDRS motor scores and comfortable gait speed (Tab. 4).

Table 3.
Intrarater Reliability of Tinetti Mobility Test Scores[a]

Rater	ICC (95% CI)
Student rater 1	.88 (.76–.94)
Student rater 2	.88 (.77–.94)
Student rater 3	.69 (.44–.83)
Student rater 4	.80 (.62–.90)
Therapist rater 1	.86 (.70–.93)
Therapist rater 2	.79 (.59–.90)

[a] ICC=intraclass correlation coefficient, CI=confidence interval.

Part 4: Concurrent Criterion-Related Validity

The ability of the TMT to positively identify fall risk when the condition history of falls was truly present was 76% (Tab. 5). Thus, the TMT positively identified the majority of individuals with PD and a known history of falls. The ability of the TMT to obtain a negative test (TMT of ≥20) when the condition history of falls was absent was 66% (Tab. 5).

Part 5: Cutoff Score Determination

The validity of TMT scores as a screening tool for identifying individuals with PD who are at risk for falls was determined by evaluating the ability of different cutoff values to accurately identify subjects with a history of falls. Out of the 156 subjects participating in this part of the study, 22% reported falling one or more times in the past week and 46% reported falling in the past 6 months. Examination of the ROC curves showed that the best possible area under the curve (AUC) value occurred for a score of 20 (AUC=72%).

A cutoff score of 20 (a score of <20 is positive for identifying subjects who are fallers) optimized sensitivity, specificity, and likelihood ratios (Tabs. 5 and 6). One-week fall history data were more sensitive, whereas the 6-month data were more specific for identifying fallers (Tab. 6).

Table 4.
Comparison of Spearman Rho Correlations (r_s) Among Clinical Test Scores, Unified Parkinson's Disease Rating Scale (UPDRS) Scores, and Comfortable Gait Speed for This Study and Previous Studies[a]

Study	UPDRS Motor Subscale	Comfortable Gait Speed
This study (N=30)		
Total TMT	−.45 (P<.05)	.53 (P<.01)
TMT balance subscale	−.40 (P<.05)	.52 (P<.01)
TMT gait subscale	−.43 (P<.05)	.50 (P<.01)
Brusse et al[38] (N=23)		
Forward FRT	−.45 (P<.05)	.21 (NS)
TUG	.58 (P<.01)	−.67 (P<.001)
BBS	−.69 (P<.001)	−.73 (P<.001)
Franchignoni and Velozo[39] (N=70)		
BBS	−.56 (P<.001)	
Qutubuddin et al[40] (N=38)		
BBS	−.58 (P<.005)	
Kokko et al[42] (N=40)		
BBS		.56

[a] TMT=Tinetti Mobility Test, FRT=Functional Reach Test, TUG=Timed "Up & Go" Test, BBS=Berg Balance Scale, NS=not significant.

Discussion

This study is the first to examine interrater and intrarater reliability and concurrent validity of TMT scores when the test was administered to individuals in the early to moderate stages of PD. Our findings are similar to previous reports of high reliability between raters for the balance or gait portions of the TMT when administered to elderly individuals,[10,15] individuals in the early to moderate stages of ALS,[19] and individuals with chronic stroke.[16] In agreement with previous findings,[10] no substantial differences were found in the ICCs of total TMT scores between physical therapist and physical therapist student raters (Tab. 2), suggesting that more clinical experience or education does not necessarily improve reliability.

The TMT scores were significantly negatively correlated with UPDRS motor examination scores (r_s=−.45, P<.05), indicating that both tests measure constructs of postural control and mobility, including rising from a chair (UPDRS item 27; TMT items 2 and 3), standing posture (UPDRS item 28; TMT item 15), postural stability (UPDRS item 30; TMT item 6), and gait (UPDRS item 29; TMT items 10–16). Our results compare well with the reported correlations between the UPDRS motor subscale and other functional balance and mobility measures (Tab. 4).[38–40]

Table 5.
Concurrent Criterion-Related Data for Fall Risk[a]

Score	Presence of Falls in the Last Week		No Falls in the Last Week		Total
TMT score of <20	25*	(a)	39†	(b)	64
TMT score of ≥20	8‡	(c)	77§	(d)	85
Total	33		116		149

[a] A Tinetti Mobility Test (TMT) score of <20 was the fall risk criterion, compared with the criterion standard of a reported history of falls in people with Parkinson disease. Sensitivity=a/(a + c)=76%, specificity=d/(b + d)=66%, positive predictive value=a/(a + b)=39%, and negative predictive value=d/(c + d)=91%. *=True positives, people with a history of falls correctly identified as at risk for falls. †=False positives, people incorrectly identified as at risk for falls. ‡=False negatives, people incorrectly identified as not at risk for falls. §=True negatives, people with no history of falls correctly identified as not at risk for falls.

Table 6.
Validity Values for Fall History Data (n=149)

Tinetti Mobility Test Cutoff Scores	Positive Predictive Value (95% CI)[a]	Negative Predictive Value (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)	Positive Likelihood Ratio (95% CI)	Negative Likelihood Ratio (95% CI)
Fall data for past week						
18	34 (22–42)	85 (76–91)	58 (39–74)	68 (59–76)	1.80 (1.2–2.7)	0.62 (0.4–0.9)
19	36 (24–49)	87 (77–92)	64 (45–79)	67 (59–75)	1.94 (1.3–2.8)	0.54 (0.3–0.9)
20	39 (27–52)	91 (82–96)	76 (57–88)	66 (57–75)	2.25 (1.64–3.1)	0.37 (0.2–0.67)
21	37 (26–49)	90 (81–95)	76 (57–88)	63 (53–71)	2.04 (1.5–2.8)	0.39 (0.2–0.7)
22	36 (25–48)	91 (82–96)	79 (61–90)	60 (50–69)	1.96 (1.48–2.6)	0.35 (0.2–0.7)
23	34 (24–45)	93 (83–97)	85 (67–94)	53 (44–62)	1.80 (1.4–2.3)	0.29 (0.13–0.65)
Fall data for past 6 mo						
18	64 (50–76)	68 (57–77)	55 (42–67)	76 (65–84)	2.26 (1.46–3.51)	0.60 (0.46–0.79)
19	66 (53–78)	70 (59–79)	59 (46–71)	76 (65–84)	2.45 (1.59–3.77)	0.54 (0.40–0.73)
20	66 (53–77)	72 (61–81)	64 (51–75)	73 (62–82)	2.4 (1.6–3.6)	0.49 (0.36–0.69)
21	63 (51–74)	72 (60–81)	65 (52–76)	70 (59–79)	2.16 (1.49–3.13)	0.50 (0.35–0.70)
22	62 (49–73)	71 (60–81)	67 (54–78)	66 (55–76)	2.0 (1.41–2.81)	0.50 (0.35–0.71)
23	58 (46–68)	72 (59–82)	72 (59–82)	58 (46–68)	1.70 (1.27–2.28)	0.49 (0.33–0.73)
24	57 (46–67)	75 (61–84)	78 (65–87)	53 (42–64)	1.65 (1.27–2.14)	0.42 (0.26–0.67)

[a] 95% CI=95% confidence interval.

The moderate positive correlation found between total TMT scores and comfortable gait speed (r_s=.53, P<.01) was not surprising, because approximately half of the items on the test measure different aspects of gait function. Thomas and Jankovic[41] reported that modified Tinetti Gait Test (TGT) total scores (ie, modified so that higher scores indicate poor gait performance) were significantly correlated (P<.01) with parameters of gait, including mean velocity (r_s=−.71), mean step time difference (r_s=.58), mean functional ambulatory performance (r_s=.63), and mean left and right step function (r_s=−.75 and −.61, respectively) obtained with the GAITRite electronic walkway[§§] in 35 patients with PD. The correlation of comfortable gait speed with the TMT scores was similar to or better than correlations reported for the forward FRT, the TUG, and the BBS[38,42] (Tab. 4) in individuals with PD, reflecting the close association of static and dynamic balance function to gait performance.

The validity results support the use of the TMT to screen individuals with PD for risk of falling in order to appropriately prescribe a fall prevention intervention. For a screening tool such as the TMT to minimize categorizing a person who is a true faller as not being at risk of falling (ie, false negatives), the cutoff value utilized should optimize sensitivity and negative likelihood ratios. A cutoff value of 23 optimized sensitivity and negative likelihood ratios for both the 6-month and 1-week fall history data. However, if a clinician desires to optimize both sensitivity and specificity to identify only those who are at high risk of falling, a cutoff score of 20 is supported by both sets of data. Differences in validity values in 1-week fall history data versus 6-month fall history data may be due to: (1) decreased subject recall errors; (2) subjects who fell during the previous 6 months obtaining an assistive device or changing their medication regimen to prevent falls; and (3) subjects who fell in the last week falling more frequently and having more abnormalities in balance and gait.

Concerning the 1-week fall history data, 90% of subjects with a negative test did not have a history of falls, and only 10% of subjects were misclassified as nonfallers. Subjects with a score of less than 20 were approximately 2 times more likely to be fallers than nonfallers. Taken together, the 1-week and 6-month results suggest that clinicians can be confident in identifying individuals

[§§] CIR Systems, MAP/CIR Inc, 1625 E Darby Rd, Havertown, PA 19083.

with PD who are at high risk for falling using a criterion score of 20 and those at moderate to high risk using a criterion score of 23. However, the moderately high sensitivity of the TMT implies that some individuals with PD will be misclassified as being at risk for falls. Therefore, we recommend that clinicians perform a multifactorial fall risk assessment once they have screened individuals on the TMT.

The TMT is a better predictor of fall risk in individuals with PD compared with several other clinical balance tests. Our findings show that the TMT has a much higher sensitivity (0.76) than the FRT, TUG, DGI, and BBS (sensitivity of <0.60) when a cutoff score that is almost identical to the score reported in elderly people is used.[6,7] The sensitivity of the TMT also was similar to that reported for the BBS, with a cutoff score of 54 (0.79).[6] The wider range of values (20–28) between the cutoff and maximum score for the TMT compared with the BBS (54–56) allows for gradations in fall risk categories, so that small fluctuations in a person's performance or therapist ratings will not radically change his or her fall risk status. Unlike the BBS, the TMT incorporates measures of ambulation as well as balance. This difference may be clinically important because previous studies[3,25] have noted that individuals with PD report that they fall when ambulating and during transitions. The TMT also takes 10 to 15 minutes less to administer than the BBS, making it a more efficient tool to use when the clinician's time with the patient is limited. The sensitivity of the TMT to predict falls in individuals with PD also was higher than the sensitivity of a combination of prior falls history, disease severity, and Romberg test results reported by Bloem et al.[3] Physical therapists can administer the TMT in a much shorter time and gain more information about gait performance needed to design treatment plans and gait interventions than the information gained from the UPDRS and Romberg test.

There are several limitations to the use of the TMT for assessing individuals with PD. The TMT has limited usefulness for evaluating the balance status of individuals in the later stages of the disease (ie, Hoehn and Yahr late stage 4 or 5) due to a floor effect. The sensitivity of the TMT to detect changes in balance and gait performance over time has not been fully explored and needs to be investigated. Shore et al[17] examined the ability of the TMT to detect changes in gait after shunt placement in individuals with normal pressure hydrocephalus and found a moderate to high correlation with the GAITRite system.

Behrman et al[43] reported that TGT scores did not detect changes in gait under 4 verbally instructed conditions that were detected with motion analysis in 10 patients with PD. However, the results of this study are questionable because 6 out of the 10 patients received perfect or nearly perfect ratings on the TGT (11 or 12) during normal gait, thereby preventing detection of changes during the experimental conditions due to a ceiling effect. Indeed, the greatest changes in TGT scores were recorded in 2 individuals who scored below 10 on the TGT during normal gait, suggesting that the TGT is sensitive to change in individuals with gait impairments. For a complete assessment of an individual's balance and gait status, clinicians must observe the person performing many different activities in a variety of environments. In addition, it is particularly important for clinicians to test individuals with PD when they are "on" and "off" medications, as performance changes under the different conditions.[44]

Conclusions

The results of this study suggest that the total score of the TMT is a reliable and valid tool for assessing the balance and gait status and fall risk of individuals in the early to middle stages of PD (Hoehn and Yahr stages 1–4). In patients who were optimally medicated, this test was able to identify individuals who were at risk for falling. Raters with differing amounts of clinical experience or education were equally reliable in administering the TMT. We believe that the TMT is a valuable examination tool that can be used by health care professionals to help make decisions regarding fall prevention in individuals with PD. Further studies are needed to determine whether the TMT can predict future falls in individuals with PD.

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Appendix.

Tinetti Mobility Test[a]

Balance Tests: Subject is seated in hard, armless chair. The following maneuvers are tested.	
Sitting balance	
Leans or slides in chair	0
Steady, safe	1
Arises	
Unable without help	0
Able, uses arms to help	1
Able, without using arms	2
Attempts to arise	
Unable without help	0
Able, requires >1 attempt	1
Able to rise, 1 attempt	2
Immediate standing balance (first 5 seconds)	
Unsteady (swaggers, moves feet, trunk sway)	0
Steady but uses walker or other support	1
Steady without walker or other support	2
Standing balance	
Unsteady	0
Steady but wide stance (heels >10.16 cm [4 in] apart) and uses cane or other support	1
Narrow stance without support	2
Nudged (subject with feet as close together as possible, examiner pushes lightly on subject's sternum 3 times)	
Begins to fall	0
Staggers, grabs, catches self	1
Steady	2
Eyes closed (subject with feet as close together as possible)	
Unsteady	0
Steady	1
Turning 360°	
Discontinuous steps	0
Continuous	1
Unsteady (grabs, staggers)	0
Steady	1
Sitting down	
Unsafe (misjudged distance, falls into chair)	0
Uses arms or not a smooth motion	1
Safe, smooth motion	2

Gait Tests: Subject stands with examiner, walks down hallway or across room, first at "usual pace," then back at "rapid, but safe pace" (using usual walking aids).	
Initiation of gait	
Any hesitancy or multiple attempts to start	0
No hesitancy	1
Step length and height	
Right swing foot does not pass left stance foot with step	0
Passes left stance foot	1
Left swing foot does not pass right stance foot with step	0
Passes right stance foot	1
Right foot does not clear floor completely with step	0
Right foot completely clears floor	1
Left foot does not clear floor completely with step	0
Left foot completely clears floor	1
Step symmetry	
Right and left step lengths not equal (estimate)	0
Right and left steps appear equal	1
Step continuity	
Stopping or discontinuity between steps	0
Steps appear continuous	1
Path (estimated in relation to floor tiles, 30.48 cm [12 in] diameter; observe excursion of 1 foot over about 3 m [10 ft] of the course)	
Marked deviation	0
Mild/moderate deviation or uses walking aid	1
Straight without walking aid	2
Trunk	
Marked sway or uses walking aid	0
No sway but flexion of knees or back or spread arms	1
No sway, no flexion, no use of arms, and no use of walking aid	2
Walking stance	
Heels apart	0
Heels almost touching while walking	1
Balance score:	__/16
Gait score:	__/12
Balance score + gait score:	__/28

[a] Modified from: Tinetti ME. Performance-oriented assessment of mobility problems in elderly patients. *J Am Geriatr Soc.* 1986;34:119–126.