Rehab Measures: Mini Balance Evaluation Systems Test

Rehabilitation Measures Database

Title of Assessment	**Mini Balance Evaluation Systems Test**
Link to instrument	**http://www.bestest.us/**
Purpose	**Clinical balance assessment tool: Shortened version of the Balance Evaluation Systems Test (BESTest), a clinical balance assessment tool that aims to target and identify 6 different balance control systems so that specific rehabilitation approaches can be designed for different balance deficits. The BESTest was shortened based on factor analysis to include dynamic balance only and to improve clinical utilization.**
Acronym	**Mini BESTest**
Instrument Reviewer(s)	**Cathy Harro MS PT, NCS & the PD EDGE Task Force of the Neurology Section of the APTA; Updated by Diane Wrisley, PT, PhD, NCS and Elizabeth Dannenbaum, MScPT for APTA Neurology Section Vestibular EDGE taskforce**
Summary Date	**04 06 2013**
Description	**Revised version of BESTest based on psychometric properties of items, item scoring, and Rasch analysis designed to improve the measurement qualities of the original test.** **Mini BESTest assesses dynamic balance, a unidimensinal construct and includes 14 items addressing 4 of the 6 sections of the original BESTest (anticipatory postural adjustments, reactive postural control, sensory orientation, dynamic gait).** **The Mini BESTest is a 14 item test scored on a 3 level ordinal scale. For the Mini BESTest, the original BESTest 4 level (0 - 3) scoring was revised to 3 levels (0 - 2) due to redundancy. Total score = 28 points per test directions. Two items have right and left assessment in which the lower score is used within the total score (directions specify which to use). For research, many studies specify use of both left and right data, thus calculating data based on 32 (vs 28) points.** **Scoring definitions and test form available at Horak's BESTest training website: http://www.bestest.us** **The Mini-BESTest was developed by Franchignoni et al, 2010.**
ICF Domain	**Body Function, Activity**
Time to Administer	**10 - 15 minutes to administer**
Number of Items	**14**
Equipment Required	• **60 cm x 60 cm block of 4" medium density Tempur foam (T41)** • **Incline ramp of 10 degree slope (2 x 2 foot**

	recommended) • **Standard chair without arm rests or wheels** • **Firm chair with arms** • **Box that is 9 inches (23 cm) in height (~2 stacked shoeboxes)** • **Stopwatch** • **Masking tape marked on floor at 3 meters from front of chair**
Training Required	• **Article review and item scoring instructions** • **Training DVD on all items of BESTest (thus including items on the Mini-BESTest) is available for purchase.**
Actual Cost	
Populations Tested	**Varied neurologic populations with balance disorders:** • **Age-Related Balance Disorders** • **Ataxia** • **Cervical Myelopathy** • **CNS Neoplasm** • **Multiple Sclerosis** • **Neuromuscular Disease** • **Nontraumatic Brain Injury** • **Parkinson's Disease** • **Peripheral Vestibular Disorders** • **Stroke** • **Traumatic Brain Injury**
Standard Error of Measurement (SEM)	**Balance Disorders:** (Godi, et al, 2013; *n* = 93 patients with balance disorders, mean age = 66.2(13.2) years, 53 female/40 male, **Dx**: *n* = 3 Parkinson's, *n* = 25 hemiplegia, *n* = 6 MS, *n* = 5 vestibular disorders, *n* = 4 neoplasm CNS, *n* = 6 neuromuscular disease, *n* = 8 hereditary ataxia, *n* = 8 poly neuropathy, *n* = 6 age-related balance disorders) • SEM = 1.26 (1.01-1.65) **Parkinson's Disease:** **(Leddy et al, 2011, subset of 24 subjects, MDS-UPDRS = 71 ± 21.9, disease duration = 6.9 ± 3.38; Hoehn and Yahr stage 1 – 2 participants, stage 2 – 11 participants, stage 2.5 – 6 participants, stage 3 – 3 participants, stage 4 – 2 participants, 21% were classified as fallers.)** • **SEM calculated = 6.16% or 1.99 points**
Minimal Detectable Change (MDC)	**Balance Disorders:** (Godi, et al, 2013) • MDC-95 = 3.5 **Parkinson's Disease:**

(Leddy et al, 2011)

- **MDC calculated = 17.1% or 5.52 points**

Minimally Clinically Important Difference (MCID)

Balance Disorders:

(Godi,et al, 2013)

- Clinically meaningful change is improvement of 4 points (out of 28 total)

Cut-Off Scores

Chronic Stroke

(Tsang et al 2013, *n* = 106 people with stroke, mean age 57.1 ± 11.0 years, 73 men, 33 women and 48 controls, mean age 60.2 ± 9.3 years, 28 men and 20 women)

- Scores of ≤ 17.5 identified those with a history of falling, sensitivity 64%, specificity 64% AUC 0.64

Parkinson's Disease:

(Leddy, et al, 2011; total sample *n* = 80, mean age = 68.2 (9.3)years, mean H & Y = 2.4 (0.64), 31% were fallers)

- Preferred Fall risk cut score 63% (20/**32** points total) had **adequate** ability to identify fallers (sensitivity = 0.88, specificity = 0.78). To maximize sensitivity and LR-, a cut score of 72% (23/32) was identified (sensitivity = 0.96, specificity = 0.47)

(Duncan, Leddy, & Earhart, 2013; *n* =56 with idiopathic PD, mean age = 69.5 years, 32 male/23 female, H&Y stage (2 = 21, 2.5 = 25, 3 = 9, 4 = 1) mean stage 2.4 (0.5))

- Using a cut score of 16/**32** points, the Mini-BESTest demonstrated **adequate** ability to predict 6-month prospective fallers (AUC = 0.80, sensitivity = 0.75, specificity = 0.79, LR+ = 3.57, LR- = 0.32). Mini-BESTest was superior to gait measures to detect fall risk in PD cohort.

(Duncan,et al, 2012; Baseline *n* = 80 PD, Six-month evaluation *n* = 51, mean age = 67.5 (8.8), years post diagnosis 7.7(3.9), H & Y stage 2.4 (0.6), UPDRS 37.8 (13.1), 27% fallers; 12-month evaluation *n* = 40, mean age 67.3 (9.5), years post diagnosis 7.2 (4.1), H&Y stage 2.3 (0.6), UPDRS 39.3 (13.3), 37% fallers)

Based on a Cut Score ≤ 20/32 points total (63%);

- **Adequate** ability to predict fallers at 6 month prospectively (AUC = 0.87, sensitivity = 0.86, specificity = 0.78, LR+ = 3.97, LR- = 0.18)

- **Adequate** ability to predict fallers at 12 months prospectively (AUC = 0.77, sensitivity = 0.62, specificity = 0.74, LR+ = 2.37, LR- = 0.52)

(Duncan, et al, 2013; *n* = 80 with idiopathic PD, mean age = 68.2 (9.7), mean MDS-UPDRS 41.3 (14.7), H & Y stage [1 = 4, 2 = 27, 2.5 = 30, 3= 13, 4= 6])

Based on a recommended Cut score ≤ 20/32 points to detect fallers:

- **Adequate** ability to identify fallers based on retrospective fall report (AUC = 0.86, sensitivity = 0.88, specificity = 0.78, LR+ = 4.03, LR- = 0.15}
- **Adequate** ability to predictive fallers based on 6 –month prospective falls (AUC = 0.87, sensitivity = 0.86, specificity = 0.78, LR+ = 3.97, LR- = 0.18); and for 12 month prospective falls (AUC = 0.77, sensitivity = 0.62, specificity = 0.74, LR+ = 2.37, LR- = 0.52)

(Mak and Auyeung 2013, *n* = 110, non-recurrent fallers n=86, 34 female, mean age 63.5± 9.3; recurrent fallers n=24, 10 female, mean age 62.2 ± 7.5)

- Scores of ≤ 19 identified recurrent fallers; sensitivity 79%, specificity 67% AUC 0.75

(King et al 2012)

- Scores of ≤ 21 differentiate those with and without postural response deficits with a sensitivity of 89%, specificity 81%

Normative Data	**Not established**
Test-retest Reliability	**Balance Disorders:** (Godi, et al, 2013; *n* = 32 patients with balance disorders, mean age = 67.3 (13.5) years, 19 female/13male, Dx: *n* = 8 Parkinson's, *n* = 7 hemiplegia, *n* = 3 vestibular disorders, *n* = 4 age-related balance disorders, 10 with "other neuro" Dx) • Test-retest 1 to 3 days after baseline assessment. **Excellent** test-retest reliability ICC = 0.96 (0.94-0.99) **Chronic Stroke** (Tsang et al, 2013) • **Excellent** for total score ICC = 0.96, Poor to excellent reliability for individual items kappa = 0.37 to 1.0 **Parkinson's Disease:**

(Leddy et al, 2011; subset of subjects *n* = 24, MDS-UPDRS = 71 (21.9), disease duration mean 6.9 (3.38), 21% fallers; H & Y stages [1 = 2, 2 = 11, 2.5 = 6, 3 = 3, 4 = 2], 21% *n* = 5 fallers)

- **Excellent** test retest reliability (ICC = 0.92)

Interrater/Intrarater Reliability

Balance Disorders:

(Godi, et al., 2013; *n* = 32 patients, sample per above)

- **Excellent** interrater reliability ICC = 0.98 (0.97-0.99)

Chronic Stroke

(Tsang et al 2013)

- **Excellent** for total scores ICC = 0.96, poor to excellent reliability for individual items kappa = 0.36 to 1.0

Parkinson's Disease:

(Leddy, et al., 2011; subset of subjects, *n* = 15 MDS-UPDRS = 74.2 (18.6), disease duration = 6.8 years (3.26), H & Y stages (1 = 2, 2 = 7, 2.5 = 3, 3 = 2, 4 = 1), 20% fallers)

- **Excellent** Inter-rater reliability (ICC = 0.91)

Internal Consistency

Balance Disorders:

(Franchignoni, et al. 2010; *n* = 115, mean age = 62.7 (16) years, 62 female/53 male, Dx: *n* = 21 Parkinson's, *n* = 15 neuromuscular disease, *n* = 14 hereditary ataxia, *n* = 11 MS, *n* = 22 hemiparesis, *n* = 7 peripheral vestibular disorders, *n* = 6 TBI, *n* = 10 nonspecific age-related balance disorders, *n* = 3 encephalopathy, *n* = 3 cervical myelopathy, *n* = 2 CNS neoplasm)

- Factor and Rasch analysis performed to identify optimal test psychometrics for item selection for Mini BESTest. High item separation reliability *r* = 0.98, Item separation index = 7.35, and Person separation reliability = 0.86 without item redundancy.

(Godi, et al., 2013; *n* = 93 patients with balance disorders, mean age = 66.2 (13.2)years, 53 female/40male, **Dx**: *n* = 3 Parkinson's, *n* = 25

hemiplegia, *n* = 6 MS, *n* = 5 vestibular disorders, *n* = 4 neoplasm CNS, *n* = 6 neuromuscular disease, *n* = 8 hereditary ataxia, *n* = 8 poly neuropathy, *n* = 6 age-related balance disorders}

- **Excellent** internal consistency at baseline testing and follow-up assessment: Cronbach alpha = 0.90 and 0.91 respectively

Chronic Stroke

(Tsang et al 2013)

- **Excellent Cronbach's alpha = 0.89, 0.93, 0.94 for each rater**

Criterion Validity (Predictive/Concurrent)

Balance Disorders:

(Godi, et al., 2013)

- **Excellent** concurrent validity of Mini-BESTest with Berg Balance Scale *r* = 0.85 (CI 0.78-0.90);
- **Excellent** validity between Mini-BESTest and mean global rating of change score in rehabilitation *r* = 0.72 (CI 0.61-0.81)

Chronic Stroke

(Tsang et al 2013)

- **Excellent** correlation with Berg Balance Scale r = 0.83
- **Adequate** correlation with Functional reach test r = 0.55
- **Excellent** correlation with one leg stand on paretic side r = 0.83
- **Adequate** correlation with one leg stand on non-paretic side r = 0.54
- **Excellent** correlation with Timed "Up & Go" r = -0.82

(Bergstrom et al 2012, *n* = 9, mean age 78.4 years, range 66-90 years, median 17 months post CVA. Swedish version)

- **Excellent** correlation with Berg Balance Scale r = 0.94
- **Excellent** correlation with Timed "Up & Go" r = -0.89

Parkinson's Disease:

(King, et al., 2012; *n* = 97, mean age 65.6 (7.1, time since diagnosis mean = 6.5 (5), H & Y mean = 2.3 (0.6) stages 1-4, UPDRS mean = 31.6 (11.2), 59 male/38 female.)

- **Excellent** concurrent validity between Mini-BESTest and Berg (*r* = 0.79);
- **Adequate** correlation between Mini-BESTest and UPDRS-disease severity (*r* = -0.51).

(Leddy, et al., 2011; total sample *n* = 80, mean age = 68.2 (9.3) years, mean H & Y = 2.4 (0.64), 31% were fallers)

- Mini-BESTest has **excellent** correlation with BESTest (*r* = 0.955)

(Duncan, et al., 2013; *n* = 80 with idiopathic PD, mean age = 68.2

(9.7), mean MDS-UPDRS 41.3 (14.7), H & Y stage [1 = 4, 2 = 27, 2.5 = 30, 3 = 13, 4 = 6])

- **Excellent** concurrent validity between the Mini-BESTest and Brief BESTest (*r* = 0.94)

(McNeely, et al., 2012; *n* = 22, mean age = 71.3 (7.6), 13 male/9 female, MMSE mean 28 (1.8), disease duration mean 7.0 (4.2) years, mean MED_UPDRS = 39.1 (9.2) off meds, 25.3 (6.9) on meds, mean H & Y stage 2.2 (0.3)

- **Excellent** concurrent validity between Mini-BESTest and Berg Balance Scale (*r* = 0.83);
- **Adequate** correlation between Mini-BESTest and Activity Specific Balance Confidence Scale ABC (*r* = 0.66).

(McNeely, et al., 2011; *n* = 23 mean age = 62 (9), mean disease duration = 15 (6) years)

- **Adequate** correlation between Mini-BESTest scores and UPDRS postural stability item (item 3.12) (r = -0.44), p < 0.001

(Duncan, et al., 2013; total *n* = 53, Off meds group *n* = 28: mean age = 70 (7.4) years, 15 males/13 females, H &Y stage 2 = 8, 2.5 = 15, 3 = 5, 3 fallers & 5 gait freezers; On meds group *n* = 53, mean age = 68 (8.5) years, 31 males/22 females, H&Y 1 = 2, 2 = 28, 2.5 = 16, 3 = 2, 4 = 5, 11 fallers and 17 gait freezers)

- **Excellent** concurrent validity between Mini-BESTest and Four square step test (*r* = -0.65) p < 0.001
- Mini-Best had **adequate** predictive validity to discriminate fallers and nonfallers with PD (AUC = 0.80, sensitivity = 0.88, specificity = 0.78); superior to 4SSS for identifying fall risk in PD.

(Duncan, Leddy & Earhart, 2011; *n* = 80 with idiopathic PD, H & Y stages I-IV, age > 40 years, no details on sample)

- **Excellent** correlation between Mini-BESTest and Five times sit to stand test (r = -0.71 p < 0.001)
- Multiple regression revealed that Mini-BESTest and Nine Hole peg test explained 53% of variance in FTSTS

(Bergstrom et al 2012, *n* = 9 with mild to moderate Parkinson disease, mean age 60.3 years, age range 46-85 years, 8 female, Hoehn and Yahr stages I-III)

- **Excellent correlation with Berg Balance Scale r = 0.94**
- **Excellent correlation with Timed "Up & Go" r = -0.81**
- **Poor correlation with Falls Efficacy Scale r = 0.26**

(Mak and Auyeung 2013)

- **The mini-BESTest score was a significant predictor of recurrent falls using multivariate logistic regression.**

Construct Validity (Convergent/Discriminant)

(Franchignoni, et al., 2010)

- Internal construct validity supported based on hierarchy of item difficulty (Rasch analysis. Item difficulty ranged from -4 to +2.5 logits)

Chronic Stroke

(Tsang et al 2013)

- The mini-BESTest discriminates between those with a history of stroke and healthy control subjects ($p < 0.001$)
- The mini-BESTest discriminates between subjects with chronic stroke with and without a history of falling ($p = 0.03$)

Parkinson's Disease:

(Leddy, et al., 2011; total sample *n* = 80, mean age = 68.2 (9.3) years, mean H & Y = 2.4 (0.64), 31% were fallers)

- Significant difference between mean Mini BESTest score of fallers= 14.3 (6.2) and nonfallers = 22.9 (5.5) in PD cohort (average difference between groups of 27%)
- Total mini-BESTest scores discriminated between fallers and non-fallers AUC = 0.86
- No specific section of the BESTest or mini-BESTest captured the primary balance deficit

(King, et al., 2012; *n* = 97 see above)

- **Excellent** ability to detect those PD patients with balance deficits based on H & Y stages 1 - 2 versus 3 - 4; AUC = 0.91; Cut off score to distinguish those with and without balance deficits ≤ **21/28** total pts (sensitivity = 89%, specificity = 81%) Mini- BESTest was superior to Berg in discriminating disease severity in PD cohort based on H & Y stage.

Content Validity

Adults with Balance Deficits

(Franchignoni, et al., 2010; *n* = 115 with diverse neurological diagnoses, 53 men, mean age 62.7 ± 16 years, diagnoses included

hemiparesis, Parkinson disease, neuromuscular diseases, hereditary ataxia, multiple sclerosis, peripheral vestibular disorders, traumatic brain injury, cervical myelopathy)

- High content validity since individual items are part of well know balance batteries, such as Berg Balance Scale, Clinical Test of Sensory Integration in Balance, Dynamic Gait Index and TUG.
- Factor analysis selected 24 out of the 36 original BESTest items likely to represent dynamic balance; Rasch analysis was used to improve rating categories and to delete 10 items that were misfitting or showed local dependency. The model was verified using confirmatory factor analysis

Face Validity

- Supported based on balance performance items that examine the construct of dynamic balance.

Floor/Ceiling Effects

Balance Disorders:

(Godi, et al., 2013)

- No evidence of floor or ceiling effect in mixed neurologic cohort at baseline mean score = 12.8 (6.9); or after treatment in rehabilitation center mean score = 15.8 (6.9); 2 participants (2.1%) reached Mini BESTest top score.

Chronic Stroke

(Tsang et al 2013)

- Skewness = - 0.81
- Floor effect: 0 participants with lowest score
- Ceiling effect: 0.9% participants with highest score

Parkinson's Disease

(King, et al., 2012; *n* = 97, see above)

- No evidence of ceiling effect, normal distribution of scores in PD cohort with varied H&Y stages, disease severity.
- Skewness -0.93

(McNeely, et al., 2012; *n* = 22, see above)

- No ceiling effect was seen in Mini BESTest scores for PD cohort as compared to ceiling effect seen in Berg scores.

(Bergstom et al., 2012)

- **no subjects scored the maximum or minimu on the mini-BESTest**

Responsiveness	**Balance Disorders** : (Godi, et al., 2012; *n* = 93 patients with balance disorders) • Subjects had 10 physical therapy treatment sessions for balance disorders. • SEM = 1.26 (1.01-1.65); MDC = 3.5 ; MCID = 4 pts; Out of 40 subjects who global rating of change was ≥ 3 (moderate to large improvement) 38/40 (95%) showed Mini-BESTest changes score ≥ 4 pts • **Excellent** ability to identify those subjects with clinically meaningful improvement: AUC = 0.92 (0.84-0.97), sensitivity = 94%, specificity = 81%, discriminative accuracy to detect moderate improvement in balance = 79% • Discriminatory accuracy excellent, area under ROC curve 0.92, to determine a moderate to large global rating of change improvement.

Professional Association Recommendations

Considerations	**The Mini-BESTest appears to have strong test psychometrics across neurologic populations with good clinical utility as a revised version of BESTest. One discrepancy noted across research however, was the total score (28 vs. 32 points) which depended on whether researchers counted both right/left sides on two test items. Note: original test published standards and instructions, state to count the lowest score of the two sides. See King & Horak, Phys Ther 2013 for a clarification on test scoring.**
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Link to instrument http://www.bestest.us/

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