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Prediction of Discharge Walking Ability From Initial Assessment in a Stroke Inpatient Rehabilitation Facility Population

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Abstract

Objectives—To (1) determine which clinical assessments at admission to an inpatient rehabilitation facility (IRF) most simply predict discharge walking ability, and (2) identify a clinical decision rule to differentiate household versus community ambulators at discharge from an IRF.

Design—Retrospective cohort study.

Setting—IRF.

Participants—Two samples of participants (n=110 and 159) admitted with stroke.

Interventions—A multiple regression determined which variables obtained at admission (age, time from stroke to assessment, Motricity Index, somatosensation, Modified Ashworth Scale, FIM, Berg Balance Scale, 10-m walk speed) could most simply predict discharge walking ability (10-m walk speed). A logistic regression determined the likelihood of a participant achieving household (<0.4m/s) versus community (0.4–0.8m/s; >0.8m/s) ambulation at the time of discharge. Validity of the results was evaluated on a second sample of participants.

Main Outcome Measure—Discharge 10-m walk speed.

Results—Admission Berg Balance Scale and FIM walk item scores explained most of the variance in discharge walk speed. The odds ratio of achieving only household ambulation at discharge was 20 (95% confidence interval [CI], 6–63) for sample 1 and 32 (95% CI, 10–96) for sample 2 when the combination of having a Berg Balance Scale score of 20 and a FIM walk item score of 1 or 2 was present.

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Conclusions—A Berg Balance Scale score of 20 and a FIM walk item score of 1 or 2 at admission indicates that a person with stroke is highly likely to only achieve household ambulation speeds at discharge from an IRF.

Keywords

Ambulation; Gait; Rehabilitation; Stroke

Admission to an inpatient rehabilitation facility (IRF) improves functional outcomes in people poststroke, with the greatest clinical gains seen in those with mild to moderate deficits.¹ The most common reason for inpatient rehabilitation referral is the inability to walk safely without physical assistance.² Independent ambulation is stated as the most frequent goal for persons who have had a stroke.³ There is a growing body of literature supporting the prognostic value of various clinical assessments in predicting walking ability at 6 months poststroke,^{4,5} and 80% to 90% of stroke patients with acute hemiparesis have been shown to achieve independent ambulation, although most still have considerable gait deficits.⁶ Walking speed is the most common indicator of walking ability in people poststroke.^{7–9} At discharge from inpatient rehabilitation, early clinical assessment data have been shown to predict walking speed. The time between assessment and prediction in these studies (ie, length of stay) was relatively long, however, averaging 26 to 60 days.^{10–12} In comparison, average lengths of stay poststroke at IRFs in the United States are currently 16 to 17 days.^{2,13}

As a result of short lengths of stay, delivery of services must be efficient,² and clinicians must make quick and accurate prognostic decisions shortly after admission about the outcome a person with stroke is expected to achieve by discharge. Early prediction of outcomes is important for (1) setting realistic and attainable therapeutic goals, (2) facilitating proper discharge planning, and (3) anticipating the need for specific durable medical equipment, home modifications, and community support.¹⁴ Establishment of a clinical decision rule that can provide an estimate of a clinical outcome (discharge walking ability)¹⁵ may decrease inaccurate predictions (delayed discharges, last minute home renovations, unnecessary durable medical equipment). With the current short lengths of stay, knowledge of how assessment results at admission predict walking ability at discharge would be extremely useful to rehabilitation clinicians. For example, persons whose walking ability is expected to be poor at discharge might be best served by retraining bathing and dressing skills from a sitting position versus a standing position.

The aims of this study were to (1) determine which clinical assessments administered at admission to an IRF could most parsimoniously predict discharge walking ability in people who have had a stroke, and (2) construct a clinical decision rule to assist clinicians in differentiating between persons who will be able to ambulate in the household only versus in the community at the time of discharge from an IRF. This study capitalizes on an established clinical and research infrastructure, whereby persons admitted to our IRF with the diagnosis of stroke undergo standardized assessment batteries by physical therapy, occupational therapy, and speech-language pathology services at admission and discharge.¹⁶ Specific assessment tools in the physical therapy battery include common measures of impairment

(eg, paresis, tone) and activity (eg, balance, walking speed). Because clinicians must make prognostic decisions for all persons with stroke, our sample includes both those with first stroke and those with recurrent strokes. Walking ability was quantified by speed on the 10-m walk test. This measure is commonly used in both clinical practice and in research studies,^{17,18} it is quick to administer, and does not have ceiling effects like the FIM.¹⁹ We hypothesized that information from the admission assessment could be used to reasonably predict discharge walking ability.

METHODS

Data for this retrospective cohort study were obtained through participant records stored in the Brain Recovery Core database. The Brain Recovery Core is a partnership between Washington University School of Medicine, Barnes Jewish Hospital, and The Rehabilitation Institute of St. Louis. The Brain Recovery Core is a system of organized stroke rehabilitation across the continuum of care, from the acute stroke service to return to home and community life.¹⁶ As part of the system, rehabilitation data are stored from participants across all 3 institutions. All participants entered into the database have a primary stroke diagnosis and have provided informed consent to have their stroke rehabilitation data stored and used for research. Washington University Human Research Protection Office has approved the database and studies using deidentified data.

Two separate samples were extracted from the database; the first was used to generate the model and clinical decision rule, and the second was used to validate them. The first sample was from April 2010 to January 2011 and contained 227 records. The second sample was from February 2011 to February 2012 and contained 288 records. All participants admitted to The Rehabilitation Institute of St. Louis undergo standardized assessments by physical therapy, occupational therapy, and speech-language pathology within 48 hours of admission and discharge as part of the Brain Recovery Core system.¹⁶ All assessments are administered by licensed clinicians who have been trained on these assessments, complete annual competencies on them, and who are observed for consistency. All participants received standard physical therapy of 1 hour per day, 5 times per week, similar to other institutions across the United States.²⁰ Standard physical therapy in our facility most often includes gait (overground or with a gait assist machine), balance, transfer, and stair training, and therapeutic exercises.

Variables Assessed

Independent variables from the physical therapy admission assessment included the Motricity Index,^{4,21} somatosensation of the dorsum of the foot,^{22,23} Modified Ashworth Scale for plantarflexors,²⁴ FIM walk item,^{25–27} the Berg Balance Scale,^{28,29} and 10-m walk speed.^{8,17,18,25} Where applicable, the affected side was used for analysis. For the 10-m walk, participants were asked to walk at a self-selected pace. They could walk with an assistive device as necessary. Participants who could not walk without physical assistance from another person were assigned a walking speed of 0m/s.^{30,31} In addition to the above clinical assessments, age and time from stroke onset to assessment at the IRF were also obtained and

included as independent variables. The dependent variable, discharge 10-m walk speed, was obtained at the physical therapy discharge assessment.

Statistical Analysis

SPSS version 19^a was used for all statistical analyses, and the criterion for statistical significance was set at $P < .05$. Distributions of independent and dependent variables were examined using Kolmogorov-Smirnov tests. We first examined distributions of participants with first strokes versus those with multiple strokes. We used t tests to determine whether differences existed between the groups on all variables. If no statistical difference was found, then all participants were analyzed together.

Starting with the first sample, Pearson product-moment correlations were used to examine relationships between the independent variables and the dependent variable. All independent variables were entered into a backward, stepwise multiple regression model to determine the most parsimonious combination of variables that could explain variance in the discharge 10-m walk speed. The probability of F for entry was $P = .05$, and for removal was $P = .10$. Squared semipartial correlations from the regression model were used to determine the amount of unique variance attributed to each significant independent variable.

A logistic regression model was used to determine the likelihood of achieving household ($<0.4\text{m/s}$) versus community (limited community, $0.4 - 0.8\text{m/s}$; full community, $>0.8\text{m/s}$) ambulation speeds.⁸ The dependent variable was dichotomized into household and community ambulation to yield a simple rule by which clinicians can predict the probability of a participant ambulating only at a household level at the time of discharge from an IRF. Sensitivity, specificity, positive and negative predictive values, and their 95% confidence intervals (CIs) were generated from the logistic model.^{32,33} Finally, the multiple and logistic regression models were checked for validity by replicating the above analyses on the second sample.

RESULTS

Of the 227 participants screened for sample 1, 110 were included (fig 1A); of the 288 participants screened for sample 2, 159 were included (fig 1B). Characteristics for each sample are shown in the upper half of table 1. The values in table 1 indicate that both samples were reasonably representative of IRF stroke populations in the United States, but with higher percentages of African Americans. Descriptive statistics for admission variables and discharge walking ability are shown in the lower half of table 1. At admission, most participants required moderate to maximal assist for mobility, demonstrated poor balance, and were unable to walk independently. At discharge, 10-m walk speeds for both samples were more variable, ranging from 0 to 2.2m/s . The t tests for all independent and dependent variables compared participants who had a first stroke with participants who had multiple strokes, but found no significant differences between the groups (all P values $> .05$); participants with 1 or multiple strokes were grouped together for all subsequent analyses.

^aIBM Corporation, 1 New Orchard Rd, Armonk, NY 10504-1722.

Generating the Model and Clinical Decision Rule: Sample 1

Table 2 shows correlations between the independent variables and the dependent variable. Of the 8 admission variables, 7 were significantly associated with discharge 10-m walk speed. The Berg Balance Scale had the highest correlation of .72. For the regression analysis, 2 variables, the Berg Balance Scale ($B=.02$, $SE=.003$; $\beta=.55$, $P=.001$) and the FIM walk item ($B=.10$, $SE=.03$; $\beta=.37$, $P=.001$), remained in the final model, explaining a total of 81% of the variance in discharge walking speed ($R^2=.81$; $P<.001$). Squared semipartial correlations indicated that the Berg Balance Scale uniquely explained 7% and the FIM walk item uniquely explained 3% of the total variance. Most of the variance (71%) in discharge walking speed was accounted for by the combination of the 2 variables. To better appreciate the relationships between the significant predictor variables and the dependent variable, each participant's data from sample 1 are displayed in a 3-dimensional graph (fig 2). In general, participants who have low Berg Balance Scale and FIM walk item scores at admission achieve household ambulation speeds at discharge from an IRF. Those ambulating at a community level at discharge tend to have a wider distribution of admission Berg Balance Scale scores, FIM walk item scores, or both.

The Berg Balance Scale, FIM walk item, and the interaction of the 2 scores were entered into a logistic regression model to determine whether a simple clinical decision rule could be constructed to predict whether someone would achieve household or community ambulation walking speeds at discharge. The independent variables were dichotomized as follows: Berg Balance Scale score of ≤ 20 versus >20 because this was a published cutoff representing balance impairment,³⁴ and FIM walk item score of 1 or 2 versus ≥ 3 because scores of 1 or 2 represent total to maximum assistance required for ambulation.^{25,26} The final model indicated that it was the combination of having a Berg Balance Scale score of ≤ 20 and a FIM walk item score of 1 or 2 that determined whether or not a participant would achieve household or community ambulation speeds ($B=2.97$, $SE=.59$; odds ratio [OR]=20, 95% CI of OR=6.2–61.7). The overall model correctly classified 83 (76%) of the 110 participants, with 91% of participants who achieved only household ambulation levels by discharge correctly classified. Of the misclassified participants, 22 of 27 were classified as household ambulators (false positives) but achieved walking speeds between 0.4 and 0.8m/s (limited community ambulation) by discharge. The OR, sensitivity, specificity, positive predictive values, negative predictive values, 95% CIs, and interpretations of these values are provided in table 3. Post hoc explorations of the model indicated that small manipulations of the cutoff Berg Balance Scale score (ie, 18–22) resulted in only slight changes to the B values (2.13–3.73) and ORs (18–42).

Validating the Model and Clinical Decision Rule: Sample 2

Validity was supported via a second, separate sample of IRF participants. For the multiple regression analysis, the same variables remained in the model (Berg Balance Scale: $B=.02$, $SE=.003$; $\beta=.52$, $P=.001$; FIM walk item: $B=.12$, $SE=.03$; $\beta=.38$, $P=.001$) and together explained 77% of the variance seen in discharge walking speed ($R^2=.77$; $P<.001$). For the logistic regression, the same combination of Berg Balance Scale and FIM walk item was observed ($B=3.45$, $SE=.57$; OR=32, 95% CI of OR=10.4–96.3). Correct classification occurred in 115 (72%) of the 159 cases, with 94% of participants who achieved only

household ambulation levels by discharge correctly classified (see table 3 for additional values).

DISCUSSION

Results from these IRF samples of people with stroke demonstrate that discharge walking ability can be predicted from admission assessment scores. While there were significant correlations between many of the admission assessment scores and the outcome, 2 scores, the Berg Balance Scale and the FIM walk item, predicted most of the variance in discharge walking ability. Results from the logistic regression indicate that people with a Berg Balance Scale score of ≥ 20 and a FIM walk score of 1 or 2 at the time of admission to an IRF are highly likely to achieve only household ambulation at the time of discharge.

Our finding that the Berg Balance Scale and FIM walk item scores can predict most of the variance in discharge walking ability is consistent with current literature that suggests that balance^{12,14,35–37} and initial walking function^{10,38,39} are key components in determining eventual walking ability. Previous models predicting walking ability at the time of discharge from an IRF have explained 27.5% to 66% of the variance,^{10–12} whereas the current models predicted 81% and 77%, respectively. Using these data, we have determined a clinical decision rule that can be used when treating persons with stroke during the short IRF stays currently experienced in the United States: *if a person has a Berg Balance Scale score of ≥ 20 and a FIM walk item score of 1 or 2 at admission to an IRF, then that person is likely to only achieve household ambulation speeds by the time of discharge.* This rule can facilitate discharge planning and assist the rehabilitation team with setting realistic and obtainable therapeutic goals during the planned length of stay.

The model correctly classified 91% and 94% of participants in samples 1 and 2 who achieved only household ambulation levels by discharge, and overall correctly classified most (76% and 72%, respectively) of the participants. The sensitivity and negative predictive value of the model were high (see table 3), while the specificity and positive predictive value were moderate. Previous models predicting walking outcomes during IRF stays have not reported these values, making it hard to compare to our data. Other models predicting the likelihood of independent gait at 6 months have attained similar predictive values to ours. Across the literature, the significant predictor variables vary somewhat, but generally are indexes of parietic severity,^{4,5} balance,¹² and initial walking ability.^{10,11} Differences in specific predictor variables may arise from a number of sources, such as slightly different lists of potential predictor variables, time poststroke when the predictor variables were collected, time poststroke of the predicted walking ability, and differences in patient populations (IRF patients only vs all persons with stroke admitted at an acute hospital). Driven by clinical needs, we were most interested in identifying who would achieve only household ambulation by the time of IRF discharge. These are the people who will most likely need durable medical equipment, supervision or physical assistance when performing activities of daily living, and/or structural modifications to be safe at home. Given the current short IRF length of stays in the United States for people with stroke,^{2,13} accommodations for a safe discharge need to be in place in approximately 2 weeks. If clinicians can better prepare families for the amount of assistance a patient will need,

patients poststroke may be more likely to be discharged home safely. Most of the misclassified participants who were incorrectly identified as household ambulators went on to achieve only limited community ambulation speeds. From a clinical perspective, a decision rule that underestimates discharge walking ability (overestimates discharge needs) is safer than a rule that does the reverse. The issue of safety after stroke is of utmost importance, given that 72% of this population fall within the first 6 months poststroke and are twice as likely to sustain a hip fracture from falling.^{40–42}

A strength of these results is their potential ability to generalize to other IRF stroke populations. Both samples analyzed here came from a rehabilitation database that stores clinical information on all patients admitted with stroke,¹⁶ and not from a sample with strict inclusion/exclusion criteria as is typical with data derived from experimental or clinical trial protocols. Thus, the people in this sample are similar to the people with stroke at many other IRFs in the United States, as indicated by their demographics and admission assessment scores (see table 1).⁴³ Similarly, the collected data came from assessments completed by physical therapy clinicians, not from research staff, making it more likely that the results will generalize to routine clinical practice. People in the sample received standard rehabilitation services during their length of stay. As new evidence emerges and standard stroke rehabilitation changes, future studies may be needed to reevaluate the model.

Study Limitations

Three limitations need to be considered when interpreting the results from this study. First, selection of the specific physical therapy assessments was dependent on those already in use at our facility.¹⁶ Other assessment tools, not included in our standardized battery, might have done equally well at predicting discharge walking ability. Second, there was no explicit test of the reliability of the physical therapy assessments performed. Reliability and validity for each of the assessments, however, have been previously established (see Methods). All physical therapists at our facility have been trained how to administer each clinical assessment, have to complete annual competencies on these assessments as part of their annual review, and have been observed for consistency. While it is likely that the physical therapists who administered these assessments were not as reliable as raters in a randomized controlled trial may have been, the data collected here are likely to be at least as reliable as data collected during routine clinical care at other IRFs. Third, comorbidities were not routinely collected on all participants. Because the sample consisted of all patients with stroke admitted to an IRF, we assume that participants have a variety of comorbidities. We are not able to determine whether any particular comorbidity would have influenced the results.

CONCLUSIONS

In summary, our results indicate that a person after a stroke who has the combination of a Berg Balance Scale score of 20 and a FIM walk item score of 1 or 2 on admission to an IRF is highly likely (20–32 times more likely than not) to be only a household ambulator at the time of discharge. Knowing at the time of IRF admission that a person with stroke is *not* likely to achieve community ambulation status will assist clinicians in making quick and

accurate prognostic decisions and allow for earlier discharge planning. Future studies are needed to extend the time frame of this prediction model beyond discharge from the IRF to long-term community living.

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List of Abbreviations

CI	confidence interval
IRF	inpatient rehabilitation facility
OR	odds ratio

References

1. Quinn TJ, Paolucci S, Sunnerhagen KS, et al. Evidence-based stroke rehabilitation: an expanded guidance document from the European Stroke Organisation (ESO) guidelines for management of ischaemic stroke and transient ischaemic attack 2008. *J Rehabil Med*. 2009; 41:99–111. [PubMed: 19225703]
2. Dobkin BH. Clinical practice. Rehabilitation after stroke. *N Engl J Med*. 2005; 352:1677–84. [PubMed: 15843670]
3. Bohannon RW. Rehabilitation goals of patients with hemiplegia. *Int J Rehabil Res*. 1988; 11:181–3.
4. Veerbeek JM, Van Wegen EE, Harmeling-Van der Wel BC, Kwakkel G. Is accurate prediction of gait in nonambulatory stroke patients possible within 72 hours poststroke? The EPOS study. *Neurorehabil Neural Repair*. 2011; 25:268–74. [PubMed: 21186329]
5. Sanchez-Blanco I, Ochoa-Sangrador C, Lopez-Munain L, Izquierdo-Sanchez M, Feroso-Garcia J. Predictive model of functional independence in stroke patients admitted to a rehabilitation programme. *Clin Rehabil*. 1999; 13:464–75. [PubMed: 10588532]
6. Forster A, Young J. Incidence and consequences of falls due to stroke: a systematic inquiry. *BMJ*. 1995; 311:83–6. [PubMed: 7613406]
7. Wade DT, Wood VA, Heller A, Maggs J, Langton Hewer R. Walking after stroke. Measurement and recovery over the first 3 months. *Scand J Rehabil Med*. 1987; 19:25–30. [PubMed: 3576138]
8. Schmid A, Duncan PW, Studenski S, et al. Improvements in speed-based gait classifications are meaningful. *Stroke*. 2007; 38:2096–100. [PubMed: 17510461]
9. Goldie PA, Matyas TA, Evans OM. Deficit and change in gait velocity during rehabilitation after stroke. *Arch Phys Med Rehabil*. 1996; 77:1074–82. [PubMed: 8857890]
10. Goldie PA, Matyas TA, Kinsella GJ, Galea MP, Evans OM, Bach TM. Prediction of gait velocity in ambulatory stroke patients during rehabilitation. *Arch Phys Med Rehabil*. 1999; 80:415–20. [PubMed: 10206603]
11. Kuys SS, Bew PG, Lynch MR, Morrison G, Brauer SG. Measures of activity limitation on admission to rehabilitation after stroke predict walking speed at discharge: an observational study. *Aust J Physiother*. 2009; 55:265–8. [PubMed: 19929769]
12. Tsang YL, Mak MK. Sit-and-reach test can predict mobility of patients recovering from acute stroke. *Arch Phys Med Rehabil*. 2004; 85:94–8. [PubMed: 14970975]
13. DeJong G, Horn SD, Conroy B, Nichols D, Heaton EB. Opening the black box of post-stroke rehabilitation: stroke rehabilitation patients, processes, and outcomes. *Arch Phys Med Rehabil*. 2005; 86:S1–7.

14. Kwakkel G, Wagenaar RC, Kollen BJ, Lankhorst GJ. Predicting disability in stroke—a critical review of the literature. *Age Ageing*. 1996; 25:479–89. [PubMed: 9003886]
15. Ebell M. AHRQ white paper: use of clinical decision rules for point-of-care decision support. *Med Decis Making*. 2010; 30:712–21. [PubMed: 21183758]
16. Lang CE, Bland MD, Connor LT, et al. The brain recovery core: building a system of organized stroke rehabilitation and outcomes assessment across the continuum of care. *J Neurol Phys Ther*. 2011; 35:194–201. [PubMed: 22027474]
17. Dean CM, Richards CL, Malouin F. Walking speed over 10 metres overestimates locomotor capacity after stroke. *Clin Rehabil*. 2001; 15:415–21. [PubMed: 11518442]
18. Dobkin BH. Short-distance walking speed and timed walking distance: redundant measures for clinical trials? *Neurology*. 2006; 66:584–6. [PubMed: 16505318]
19. Gorgon E, Said C, Galea M. Mobility on discharge from an aged care unit. *Physiother Res Int*. 2007; 12:72–81. [PubMed: 17536645]
20. Lang CE, Macdonald JR, Reisman DS, et al. Observation of amounts of movement practice provided during stroke rehabilitation. *Arch Phys Med Rehabil*. 2009; 90:1692–8. [PubMed: 19801058]
21. Collin C, Wade D. Assessing motor impairment after stroke: a pilot reliability study. *J Neurol Neurosurg Psychiatry*. 1990; 53:576–9. [PubMed: 2391521]
22. Sullivan JE, Hedman LD. Sensory dysfunction following stroke: incidence, significance, examination, and intervention. *Top Stroke Rehabil*. 2008; 15:200–17. [PubMed: 18647725]
23. Winward CE, Halligan PW, Wade DT. Current practice and clinical relevance of somatosensory assessment after stroke. *Clin Rehabil*. 1999; 13:48–55. [PubMed: 10327097]
24. Bohannon RW, Smith MB. Interrater reliability of a Modified Ashworth Scale of muscle spasticity. *Phys Ther*. 1987; 67:206–7. [PubMed: 3809245]
25. Finch, E., Brooks, D., Stratford, PW., Mayo, NE. Physical rehabilitation outcome measures. Hamilton: Lippincott Williams & Wilkins; 2002.
26. Keith RA, Granger CV, Hamilton BB, Sherwin FS. The Functional Independence Measure: a new tool for rehabilitation. *Adv Clin Rehabil*. 1987; 1:6–18. [PubMed: 3503663]
27. Hsueh IP, Lin JH, Jeng JS, Hsieh CL. Comparison of the psychometric characteristics of the Functional Independence Measure, 5 item Barthel Index, and 10 item Barthel Index in patients with stroke. *J Neurol Neurosurg Psychiatry*. 2002; 73:188–90. [PubMed: 12122181]
28. Berg K, Wood-Dauphinee S, Williams JI. The Balance Scale: reliability assessment with elderly residents and patients with an acute stroke. *Scand J Rehabil Med*. 1995; 27:27–36. [PubMed: 7792547]
29. Berg KO, Wood-Dauphinee SL, Williams JI, Maki B. Measuring balance in the elderly: validation of an instrument. *Can J Public Health*. 1992; 83(Suppl 2):S7–11. [PubMed: 1468055]
30. Friedman PJ. Gait recovery after hemiplegic stroke. *Int Disabil Stud*. 1990; 12:119–22. [PubMed: 2096120]
31. Hill K, Ellis P, Bernhardt J, Maggs P, Hull S. Balance and mobility outcomes for stroke patients: a comprehensive audit. *Aust J Physiother*. 1997; 43:173–80. [PubMed: 11676685]
32. Jewell, D. Guide to evidence-based physical therapy practice. Sudbury: Jones & Bartlett Learning; 2011.
33. Field, A. Discovering statistics using SPSS. Los Angeles: SAGE Publications; 2005.
34. Blum L, Korner-Bitensky N. Usefulness of the Berg Balance Scale in stroke rehabilitation: a systematic review. *Phys Ther*. 2008; 88:559–66. [PubMed: 18292215]
35. Kollen B, van de Port I, Lindeman E, Twisk J, Kwakkel G. Predicting improvement in gait after stroke: a longitudinal prospective study. *Stroke*. 2005; 36:2676–80. [PubMed: 16282540]
36. Loewen SC, Anderson BA. Predictors of stroke outcome using objective measurement scales. *Stroke*. 1990; 21:78–81. [PubMed: 2300994]
37. Keenan MA, Perry J, Jordan C. Factors affecting balance and ambulation following stroke. *Clin Orthop Relat Res*. 1984; (182):165–71.

38. Jorgensen HS, Nakayama H, Raaschou HO, Olsen TS. Recovery of walking function in stroke patients: the Copenhagen Stroke Study. *Arch Phys Med Rehabil.* 1995; 76:27–32. [PubMed: 7811170]
39. Rabadi MH, Blau A. Admission ambulation velocity predicts length of stay and discharge disposition following stroke in an acute rehabilitation hospital. *Neurorehabil Neural Repair.* 2005; 19:20–6. [PubMed: 15673840]
40. Ganz DA, Bao Y, Shekelle PG, Rubenstein LZ. Will my patient fall? *JAMA.* 2007; 297:77–86. [PubMed: 17200478]
41. Shumway-Cook A, Baldwin M, Polissar NL, Gruber W. Predicting the probability for falls in community-dwelling older adults. *Phys Ther.* 1997; 77:812–9. [PubMed: 9256869]
42. Weerdesteyn V, de Niet M, van Duijnhoven HJ, Geurts AC. Falls in individuals with stroke. *J Rehabil Res Dev.* 2008; 45:1195–213. [PubMed: 19235120]
43. Granger CV, Markello SJ, Graham JE, Deutsch A, Ottenbacher KJ. The Uniform Data System for Medical Rehabilitation: report of patients with stroke discharged from comprehensive medical programs in 2000–2007. *Am J Phys Med Rehabil.* 2009; 88:961–72. [PubMed: 19935180]

Fig 1.

(A) Of the 227 participants initially screened for sample 1, 110 participants consented and had available clinical assessments for analysis. (B) Of the 288 participants initially screened for sample 2, 159 participants consented and had available clinical assessments for analysis.

Walking Speed (m/s)

- < 0.4 Household ambulation
- 0.4-0.8 Limited community ambulation
- * > 0.8 Community ambulation

Fig 2.

Three-dimensional representation of the multiple regression model for sample 1. Each data point is a participant. Data points from participants with the same score across all 3 measures (eg, Berg Balance Scale=10, FIM walk item=1, 10-m walk test=0) are overlaid. The black box represents the cutoff walking speed between household and community ambulation classifications.

Table 1

Sample Characteristics, Description Statistics for Admission and Discharge Variables

Characteristics	Sample 1 (n=110)	Sample 2 (n=159)
Age at stroke (y)	62±14 (26–89)	63±15 (21–93)
Sex		
Women	59 (54)	75 (47)
Men	51 (46)	84 (53)
Race		
African American	64 (58)	103 (65)
White	44 (40)	53 (33)
Asian	1 (1)	1 (1)
Other	1 (1)	2 (1)
First stroke	73 (66)	109 (69)
Type of stroke		
Ischemic	74 (67)	107 (67)
Hemorrhagic	18 (16)	19 (12)
Unknown/missing	18 (16)	33 (21)
Affected side		
Left	52 (47)	54 (34)
Right	37 (34)	70 (44)
Bilateral	7 (6)	9 (6)
Unknown/missing	14 (13)	26 (16)
Stroke-IRF assessment (d) *	5±4 (2–60)	4±5 (1–91)
Length of stay (d) *	14±10 (3–74)	17±14 (3–63)
Admission	Sample 1	Sample 2
Lower extremity		
Motricity Index [†]	65±26 (0–100)	59±30 (0–100)
Somatosensation [†]		
Intact	63 (57)	95 (60)
Impaired	24 (22)	24 (15)
Absent	9 (8)	7 (4)
Not tested	7 (6)	29 (18)
Missing	7 (6)	4 (3)
Modified Ashworth Scale [‡]		
0	64 (58)	118 (74)
1	12 (11)	18 (11)
1+	2 (2)	7 (4)
2	3 (3)	5 (3)
3	2 (2)	3 (2)
4	0 (0)	0 (0)

Characteristics	Sample 1 (n=110)	Sample 2 (n=159)
Not tested	2 (2)	4 (3)
Missing	25 (23)	4 (3)
FIM walk item *	1±1 (1–6)	1±2 (1–5)
Berg Balance Scale	16±14 (0–50)	16±15 (0–50)
10-m walk speed (m/s) *	0±0 (0–1.2)	0±0 (0–1.4)
Discharge	Sample 1	Sample 2
10-m walk speed (m/s) *	0.5±0.8 (0–1.8)	0.4±0.9 (0–2.2)

NOTE. Values are mean ±SD (range), n (%), or as otherwise indicated; *t* tests indicated that the samples were not statistically different from each other (all *P* values >.05).

* Median±interquartile range (range).

† Affected or more involved side.

Table 2

Pearson Product-Moment Correlations Between Variables for Sample 1^{*}

Variables	Discharge 10-m Speed	Motricity Index	Somatosensation	Modified Ashworth Scale	FIM Walk Item	Berg Balance Scale	Admission 10-m Walk Speed	Age at Stroke
Motricity Index	.47 [†]							
Somatosensation	.08	.30						
Modified Ashworth Scale	-.20 [†]	-.12	-.08					
FIM walk item	.64 [†]	.42	.06	-.18				
Berg Balance Scale	.72 [†]	.63	.13	-.13	.70			
Admission 10-m walk speed	.27 [†]	.20	.07	-.09	.23	.42		
Age at stroke	-.29 [†]	.03	.10	-.07	-.20	-.25	-.11	
Stroke to IRF assessment	-.24 [†]	-.34	-.32	.06	-.16	-.23	-.04	-.07

NOTE. Correlations .20 are significant at $P<.05$ level.^{*} Correlation coefficients between variables were similar across the 2 samples.[†] Significant correlations between the dependent variable and the independent variable.

Table 3

OR, Sensitivity, Specificity, and Positive and Negative Predictive Values From the Logistic Regression *

Statistical Measures	Values	95% CI	Interpretation
OR	20 [32]	6.2–62 [10–96]	Persons with a BBS ≤ 20 and a FIM walk score of 1 or 2 are 20–32 times more likely to only achieve household ambulation by discharge, compared with those who do not have this combination of scores.
Sensitivity	.91 [.94]	.86–.97 [.90–.98]	91%–94% chance that persons with a BBS ≤ 20 and a FIM walk score of 1 or 2 will only achieve household ambulation by discharge.
Specificity	.65 [.60]	.56–.74 [.52–.68]	60%–65% chance that persons with a BBS >20 and a FIM walk score of ≥ 3 will achieve community ambulation by discharge.
Positive predictive value	.66 [.70]	.58–.76 [.63–.77]	66%–70% of people with a BBS ≤ 20 and a FIM walk score of 1 or 2 will only achieve household ambulation by discharge.
Negative predictive value	.91 [.93]	.86–.96 [.89–.97]	91%–93% of people with a BBS >20 and a FIM walk score of ≥ 3 will achieve community ambulation by discharge.

Abbreviation: BBS, Berg Balance Scale.

* For each row, sample 1 values are provided first, with sample 2 values below in brackets.