Ability of Functional Independence Measure to accurately predict functional outcome of stroke-specific population: Systematic review

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Abstract—Stroke is a leading cause of functional impairments. The ability to quantify the functional ability of poststroke patients engaged in a rehabilitation program may assist in prediction of their functional outcome. The Functional Independence Measure (FIM) is widely used and accepted as a functional-level assessment tool that evaluates the functional status of patients throughout the rehabilitation process. From February to March 2009, we searched MEDLINE, Ovid, CINAHL, and EBSCO for full-text articles written in English. Article inclusion criteria consisted of civilian and veteran patients posthemorrhagic and ischemic stroke with an average age of 50 years or older who participated in an inpatient rehabilitation program. Articles rated 5 or higher on the PEDro (Physiotherapy Evidence Database) scale were analyzed, including one cluster randomized trial and five cohort studies. Descriptive and psychometric data were outlined for each study. Key findings, clinical usefulness of the FIM, potential biases, and suggestions for further research were summarized. Although limited, evidence exists that FIM scores can be used as an accurate predictor of outcomes in poststroke patients.

Key words: civilian, CVA, discharge disposition, FIM, length of stay, outcomes, predictability, rehabilitation, stroke, veterans.

INTRODUCTION

Cerebrovascular accidents (CVAs), or strokes, remain a major healthcare problem in terms of their human and economic toll. More than 700,000 strokes occur in the United States each year, resulting in more than 160,000 deaths annually, with 4.8 million stroke survivors alive today [1–2]. From 1988 to 1997, the age-adjusted stroke hospitalization rate grew 18.6 percent (from 560 to 664 per 100,000), while total stroke hospitalizations increased 38.6 percent (from 592,811 to 821,760 annually) [3]. In 2004, the cost of stroke was estimated at $53.6 billion (direct and indirect costs), with a mean lifetime cost estimated at $140,048 per event [1]. Stroke is also a leading cause of functional impairments, with 20 percent of survivors requiring institutional care after 3 months and 15 to 30 percent being permanently disabled [1].

The Functional Independence Measure (FIM) was designed to provide a consistent data collection tool for comparison of rehabilitation outcomes across the continuum of healthcare. Additionally, the FIM attempts to establish a means of collecting rehabilitation data in a consistent manner [4]. The FIM was designed to allow clinicians to track changes in the functional status of their patients from the onset of rehabilitative care through discharge and follow-up [2]. The FIM outcomes management tool is widely used in settings like skilled nursing facilities (SNFs); acute, subacute, and rehabilitation hospitals; and Department of Veterans Affairs (VA) programs.

The 18 items on the FIM assess the patient's degree of disability and burden of care. Thirteen items define disability in motor functions and five define disability in cognitive functions [5]. Each item is rated on a 7-point scale, with 1 = total assist (<25% independence) and 7 = complete independence (100% independence). Ratings are accumulated across items and are also used to determine the degree of help the patient needs to accomplish basic, routine daily tasks. The degree of dependency ranges from no helper to complete dependence on a helper. The FIM is routinely performed first at admission to the rehabilitative setting and then at discharge from the setting [6].

Since its creation more than 20 years ago, the FIM has been widely utilized, as evidenced by its use for multiple pathologies including stroke, traumatic brain injury, cancer, and spinal cord injury. Physical rehabilitation, including physical therapy, occupational therapy, and speech therapy, has been shown to improve the functional outcomes of patients who have had a stroke [5,7]. Early, aggressive therapy can improve the likelihood of a more positive outcome [7]. However, because therapy is tailored to meet the needs of the individual patient and because treatment techniques or preferred treatment patterns are varied among individual therapists, predicting functional outcomes has been a challenge [7]. The purpose of this systematic review was to evaluate the ability of the FIM to predict the functional outcome for civilian and veteran patients who had survived a stroke.

METHODS

Search Strategies

A comprehensive search of MEDLINE, Ovid, CINAHL, and EBSCO was performed with use of the following terms: FIM or Functional Independence Measure, stroke or CVA or cerebrovascular accident, outcomes, and veteran or military. In addition, the following restrictions were applied: English-language articles and full-text available with no restriction to time.

Article Selection

We screened the abstracts of articles to identify relevant studies. Reviewers independently identified studies that satisfied the inclusion criteria, while noting studies that they excluded. Inclusion criteria were subjects who were civilians and veterans, posthemorrhagic and ischemic stroke, an average age of 50 years old, male and female, and participating in an inpatient rehabilitative program. Exclusion criteria were articles in a language other than English and articles that were not full text.

The studies that met the inclusion criteria were then screened by two additional reviewers. Any disagreements regarding satisfaction of inclusion criteria were resolved by consensus. Data from each included study were then independently extracted by three reviewers using a data-extraction sheet. Types of extracted data included type of study, selection criteria for participants, outcomes measured, mean age of participants, military or civilian, blinding of subjects, and blinding of assessors.

Each included study was then independently evaluated by three reviewers using the Physiotherapy Evidence Database (PEDro) scale (**Table 1**). The PEDro scale was chosen over any other scale because of its applications to therapy and considerations for therapeutic intervention and outcomes. The PEDro scale allows the rating of blinding and randomization and the identification of homogeneous versus heterogeneous intervention groups and key outcome measures. Any disagreements regarding PEDro criteria were resolved by consensus. Studies rated 5 or higher in our PEDro evaluation were considered in our systematic review, while studies rated less than 5 were excluded. A rating of 5 was chosen as an arbitrary cutoff because the reviewers felt this would provide strong levels of evidence. Of the 18 studies that satisfied our inclusion criteria, only 6 received a PEDro score of 5 or higher.

Types of Studies

Most of the studies included were level 1b or 2b studies, which include cohort studies (longitudinal) and randomized controlled trials (RCTs). The cohort studies compared FIM data from patients during an inpatient rehabilitation stay to assess functional status, length of stay, discharge destination,

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Table 1.
Physiotherapy Evidence Database (PEDro) evaluation of selected articles on patients with stroke who participated in inpatient rehabilitation programs.

Study	PEDro Criterion Score											Total Score	Quality	Level*
	1	2	3	4	5	6	7	8	9	10	11			
Black et al., 1999 [1]	Y	N	N	Y	N	N	N	Y	Y	Y	Y	5	High	2b
Denti et al., 2008 [2]	Y	N	N	Y	N	N	N	Y	Y	Y	Y	5	High	1b
Hsueh et al., 2002 [3]	Y	N	N	Y	N	Y	Y	Y	N	Y	Y	6	High	1b
Inouye et al., 2001 [4]	Y	N	N	Y	N	N	N	Y	Y	Y	Y	5	High	2b
Strasser et al., 2008 [5]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10	High	1b
Tur et al., 2003 [6]	Y	N	N	Y	N	N	N	Y	Y	Y	Y	5	High	2b
Bates and Stineman, 2000 [7]	Y	N	N	N	N	N	N	Y	N	N	Y	2	Low	2b
Brosseau et al., 1996 [8]	Y	N	N	Y	N	N	N	Y	N	Y	Y	4	Low	2b
Inouye et al., 2000 [9]	Y	N	N	Y	N	N	N	Y	N	Y	Y	4	Low	2b
McKenna et al., 2002 [10]	Y	N	N	Y	N	N	N	Y	N	Y	Y	4	Low	2b
Reker et al., 2005 [11]	N	N	N	Y	N	N	N	Y	N	N	Y	2	Low	2b
Ring et al., 1997 [12]	Y	N	N	Y	N	N	N	Y	N	Y	Y	4	Low	1b
Shelton et al., 2001 [13]	Y	N	N	Y	N	N	N	Y	N	Y	Y	4	Low	2b
Kwon et al., 2004 [14]	Y	N	N	Y	N	N	N	N	N	Y	Y	3	Low	1b
Stineman et al., 1997 [15]	Y	N	N	Y	N	N	N	Y	N	Y	Y	4	Low	2b
Streppel and Van Harten, 2002 [16]	Y	N	N	Y	N	N	N	Y	N	N	Y	3	Low	1b
Whitson et al., 2006 [17]	Y	N	N	Y	N	N	N	Y	N	N	Y	3	Low	2c
Wilson et al., 1991 [18]	N	N	N	Y	N	N	N	Y	N	Y	Y	4	Low	2b

*Oxford Centre for Evidence-based Medicine Levels of Evidence.

1. Black TM, Soltis T, Bartlett C. Using the Functional Independence Measure instrument to predict stroke rehabilitation outcomes. Rehabil Nurs. 1999:24(3): 109–14, 121. [PMID: 10754896]

2. Denti L, Agosti M, Franceschini M. Outcome predictors of rehabilitation for first stroke in the elderly. Eur J Phys Rehabil Med. 2008;44(1):3–11. [PMID: 18385622]

3. 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(2):188–90. [PMID: 12122181]
   DOI:10.1136/jnnp.73.2.188

4. Inouye M, Hashimoto H, Mio T, Sumino K. Influence of admission functional status on functional change after stroke rehabilitation. Am J Phys Med Rehabil. 2001;80(2):121–25. [PMID: 11212012]
   DOI:10.1097/00002060-200102000-00008

5. Strasser DC, Falconer JA, Stevens AB, Uomoto JM, Herrin J, Bowen SE, Burridge AB. Team training and stroke rehabilitation outcomes: A cluster randomized trial. Arch Phys Med Rehabil. 2008;89(1):10–15. [PMID: 18164324]
   DOI:10.1016/j.apmr.2007.08.127

6. Tur BS, Gursel YK, Yavuzer G, Kucukdeveci A, Arasil T. Rehabilitation outcome of Turkish stroke patients: In a team approach setting. Int J Rehabil Res. 2003; 26(4):271–77. [PMID: 14634361]
   DOI:10.1097/00004356-200312000-00004

7. Bates BE, Stineman MG. Outcome indicators for stroke: Application of an algorithm treatment across the continuum of postacute rehabilitation services. Arch Phys Med Rehabil. 2000;81(11):1468–78. [PMID: 11083350]
   DOI:10.1053/apmr.2000.17808

8. Brosseau L, Philippe P, Potvin L, Boulanger YL. Post-stroke inpatient rehabilitation. I. Predicting length of stay. Am J Phys Med Rehabil. 1996;75(6):422–30. [PMID: 8985105]
   DOI:10.1097/00002060-199611000-00005

9. Inouye M, Kishi K, Ikeda Y, Takada M, Katoh J, Iwahashi M, Hayakawa M, Ishihara K, Sawamura S, Kazumi T. Prediction of functional outcome after stroke rehabilitation. Am J Phys Med Rehabil. 2000;79(6):513–18. [PMID: 11083301]
   DOI:10.1097/00002060-200011000-00007

10. McKenna K, Tooth L, Strong J, Ottenbacher K, Connell J, Cleary M. Predicting discharge outcomes for stroke patients in Australia. Am J Phys Med Rehabil. 2002;81(1):47–56. [PMID: 11807333]
    DOI:10.1097/00002060-200201000-00009

11. Reker DM, Reid K, Duncan PW, Marshall C, Cowper D, Stansbury J, Warr-Wing KL. Development of an integrated stroke outcomes database within Veterans Health Administration. J Rehabil Res Dev. 2005;42(1):77–91. [PMID: 15742252]
    DOI:10.1682/JRRD.2003.11.0164

12. Ring H, Feder M, Schwartz J, Samuels G. Functional measures of first-stroke rehabilitation inpatients: Usefulness of the Functional Independence Measure total score with a clinical rationale. Arch Phys Med Rehabil. 1997;78(6):630–35. [PMID: 9196471]
    DOI:10.1016/S0003-9993(97)90429-9

Table 1. (cont)

Physiotherapy Evidence Database (PEDro) evaluation of selected articles on patients with stroke who participated in inpatient rehabilitation programs.

13. Shelton FD, Volpe BT, Reding M. Motor impairment as a predictor of functional recovery and guide to rehabilitation treatment after stroke. Neurorehabil Neural Repair. 2001;15(3):229–37. [PMID: 11944745]
   DOI:10.1177/154596830101500311

14. Kwon S, Hartzema AG, Duncan PW, Min-Lai S. Disability measures in stroke: Relationship among the Barthel Index, the Functional Independence Measure, and the Modified Rankin Scale. Stroke. 2004;35(4):918–23. [PMID: 14976324]
   DOI:10.1161/01.STR.0000119385.56094.32

15. Stineman MG, Maislin G, Fiedler RC, Granger CV. A prediction model for functional recovery in stroke. Stroke. 1997;28(3):550–56. [PMID: 9056610]

16. Streppel KR, Van Harten WH. The Functional Independence Measure used in a Dutch rehabilitating stroke population; a pilot study to assess progress. Int J Rehabil Res. 2002;25(2):87–91. [PMID: 12021595]
   DOI:10.1097/00004356-200206000-00002

17. Whitson HE, Pieper CF, Sanders L, Horner RD, Duncan PW, Lyles KW. Adding injury to insult: Fracture risk after stroke in veterans. J Am Geriatr Soc. 2006;54(7):1082–88. [PMID: 16866679]
   DOI:10.1111/j.1532-5415.2006.00769.x

18. Wilson DB, Houle DM, Keith RA. Stroke rehabilitation: A model predicting return home. West J Med. 1991;154(5):587–90. [PMID: 1866956]
N = no, Y = yes.

cost efficiency, and overall cost of care and also compared the FIM with other outcome measures. The RCTs used data from patients with acute strokes to determine which FIM variables would best predict discharge home.

Types of Participants

Tables 2 and **3**, respectively, provide a synopsis of the demographics of the subjects and the inclusion and exclusion criteria for the particular study. The mean age for participants in the studies ranged from 61.6 ± 10.9 to 80.8 ± 4.7 years. (All data shown as mean ± standard deviation unless otherwise noted.) Although men and women were included in the studies, men represented the prominent sex. Most studies included patients for whom this was their first diagnosis of a stroke, either hemorrhagic or ischemic.

Types of Intervention

The investigators examined the use of the FIM score at admission and discharge from a rehabilitation setting to determine its predictive ability for length of stay, discharge destination, and discharge functional status, as well as the relationship of the FIM and age, cognition, and location of the lesion. One study compared the FIM with the Barthel Index (BI) (measure of disability) [8], and another study compared the FIM with the BI and the Modified Rankin Scale (MRScale) (measure of disability) [9].

Types of Outcome Measures

Functional status on admission and discharge was measured with the FIM or modified FIM, which is defined in one article as a minimum of 8/18 items scored on FIM and in another article as 13/18 items. The BI or the 5-item BI (BI-5), the Rehab Factor score, and the MRScale were all compared with the FIM in the different studies [8–9].

Synopsis of Included Studies

Black et al., 1999

Black et al. identified factors influencing discharge destination of patients with strokes [10]. A total of 234 patients with a mean age of 68.8 years admitted to a rehabilitation unit during a 2-year period were included. Subjects' demographic data (sex, marital status, living arrangements, discharge location, impairment group, and living setting) were analyzed. FIM scores were compared with functional status, demographic characteristics, and discharge destination. The median test for ordinal variables was used to examine the differences between FIM scores for those patients discharged to their homes and those discharged to an SNF. They also examined the relationship between discharge FIM scores and discharge location to see what threshold for the FIM score could predict discharge location. They concluded that the FIM could predict discharge status.

Denti et al., 2008

Denti et al. identified specific outcome determinants of 359 elderly first-stroke patients [9]. The mean subject age was 80.8 years, with all subjects being at least 75 when admitted to an inpatient rehabilitation ward. Data obtained on admission included demographics, premorbid degree of autonomy (MRScale), type of stroke (Oxfordshire Community Stroke Project), degree of impairment (Motricity Index and Trunk Control Test), cognition (Mini-Mental State Examination [MMSE]), and extent of disability (FIM). FIM score increased from 55.8 ± 24.0 to 75.3 ± 30.0 ($p < 0.0001$) from admission. The FIM admission score was the

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Table 2.
Description of studies evaluated.

Author	Study Design	Age (yr) (mean ± SD)	Sex		Primary Diagnosis	*n*
			Male	**Female**		
Black et al., 1999 [1]	Cohort	68.8 ± 13.0	131	103	Stroke	234
Denti et al., 2008 [2]	Multicenter cohort prospective	80.8 ± 4.7	136	223	Stroke	359
Hsueh et al., 2002 [3]	Cohort	67.5 ± 10.9	68	50	Stroke	118
Inouye et al., 2001 [4]	Cohort	64 ± 1	163	80	Stroke (ischemic)	243
Strasser et al., 2008 [5]	Cluster randomized trial	C = 66.6 ± 12.0 I* = 65.9 ± 11.4	337 C 225 I	9 C 7 I	Stroke	29 medical centers (15 = 346 C patients, 14 = 233 I patients)
Tur et al., 2003 [6]	Cohort	61.6 ± 10.9	56	46	Stroke	102

*Only postintervention number of patients listed.

1. Black TM, Soltis T, Bartlett C. Using the Functional Independence Measure instrument to predict stroke rehabilitation outcomes. Rehabil Nurs. 1999:24(3):109–14, 121. [PMID: 10754896]
2. Denti L, Agosti M, Franceschini M. Outcome predictors of rehabilitation for first stroke in the elderly. Eur J Phys Rehabil Med. 2008;44(1):3–11. [PMID: 18385622]
3. 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(2):188–90. [PMID: 12122181] DOI:10.1136/jnnp.73.2.188
4. Inouye M, Hashimoto H, Mio T, Sumino K. Influence of admission functional status on functional change after stroke rehabilitation. Am J Phys Med Rehabil. 2001;80(2):121–25. [PMID: 11212012] DOI:10.1097/00002060-200102000-00008
5. Strasser DC, Falconer JA, Stevens AB, Uomoto JM, Herrin J, Bowen SE, Burridge AB. Team training and stroke rehabilitation outcomes: A cluster randomized trial. Arch Phys Med Rehabil. 2008;89(1):10–15. [PMID: 18164324] DOI:10.1016/j.apmr.2007.08.127
6. Tur BS, Gursel YK, Yavuzer G, Kucukdeveci A, Arasil T. Rehabilitation outcome of Turkish stroke patients: In a team approach setting. Int J Rehabil Res. 2003; 26(4):271–77. [PMID: 14634361] DOI:10.1097/00004356-200312000-00004

C = control group, I = intervention, SD = standard deviation.

biggest predictor of outcome. Home discharge was not related to age but rather to social situation before stroke and level of cognition.

Hsueh et al., 2002

The purpose of Hsueh et al.'s prospective study was to compare the reliability, validity, and responsiveness of the motor subscale of the FIM, the original (10-item) BI, and the BI-5 [8]. A total of 118 patients poststroke (mean age 67.5 years) was included in the study. The average length of inpatient rehabilitation stay was 26 days. FIM data showed these patients to be severely disabled (mean FIM score of 28 at admission). Internal consistency of each of the activity of daily living measures was evaluated with use of Cronbach alpha coefficients ≥0.84; the BI-5 had an alpha coefficient ≥0.71.Responsiveness was measured

with the standardized response mean and was found to be ≥1.2 ($p < 0.001$) for the FIM and BI, and the BI-5 response mean was just as high [8].

Inouye et al., 2001

Inouye et al. examined the influence of admission FIM scores on functional change after stroke rehabilitation [11]. A total of 243 ischemic stroke patients were included in the study (mean age 64 years). Patients were admitted to a rehabilitation center hospital and received comprehensive physical and occupational therapy. Speech therapy was given to those patients with aphasia. The patients were divided into three categories depending on the severity of their stroke: severely affected (FIM total score <36), moderately affected (FIM total score >37 and <72), and mildly affected (FIM total score >73).

Table 3.
Inclusion and exclusion criteria for studies evaluated.

Author	Inclusion Criteria	Exclusion Criteria
Black et al., 1999 [1]	CVA. Admission 7/1994–6/1996. Discharge home or SNF.	Transferred to acute care. Discharge to another rehabilitation facility.
Denti et al., 2008 [2]	1st CVA. Admission 2/1/1999–11/30/2000. Stable medical status throughout.	>1 CVA. Subarachnoid hemorrhage. CVA secondary cerebral hemorrhage. Concurrent medical conditions to hinder rehabilitation.
Hsueh et al., 2002 [3]	CVA. Consent.	>1 CVA. Other major diseases.
Inouye et al., 2001 [4]	Onset of 1st CVA within 26 wk. Ischemic. 1 lesion (diagnosed by CT/MRI).	>1 CVA. Other neuromuscular condition(s).
Strasser et al., 2008 [5]	Onset CVA ≤90 d. VA medical center: – Subscribe FSOD – Inpatient rehabilitation unit – ≥2 CVA/mo Consent and IRB.	Incomplete FIM. <2 FIM assessments. LOS <3 d. No IRB. Do not report to FSOD.
Tur et al., 2003 [6]	1st CVA.	>1 CVA. TIA, subarachnoid hemorrhage. Bilateral cerebral lesion. Other neurological/psychiatric condition(s) to hinder rehabilitation.

1. Black TM, Soltis T, Bartlett C. Using the Functional Independence Measure instrument to predict stroke rehabilitation outcomes. Rehabil Nurs. 1999;24(3):109–14, 121. [PMID: 10754896]
2. Denti L, Agosti M, Franceschini M. Outcome predictors of rehabilitation for first stroke in the elderly. Eur J Phys Rehabil Med. 2008;44(1):3–11. [PMID: 18385622]
3. 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(2):188–90. [PMID: 12122181]
   DOI:10.1136/jnnp.73.2.188
4. Inouye M, Hashimoto H, Mio T, Sumino K. Influence of admission functional status on functional change after stroke rehabilitation. Am J Phys Med Rehabil. 2001;80(2):121–25. [PMID: 11212012]
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5. Strasser DC, Falconer JA, Stevens AB, Uomoto JM, Herrin J, Bowen SE, Burridge AB. Team training and stroke rehabilitation outcomes: A cluster randomized trial. Arch Phys Med Rehabil. 2008;89(1):10–15. [PMID: 18164324]
   DOI:10.1016/j.apmr.2007.08.127
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   DOI:10.1097/00004356-200312000-00004

CT = computed tomography, CVA = cerebrovascular accident, FIM = Functional Independence Measure, FSOD = Functional Status and Outcomes Database, IRB = institutional review board, LOS = length of stay, MRI = magnetic resonance imaging, SNF = skilled nursing facility, TIA = transient ischemic attack, VA = Department of Veterans Affairs.

The authors gathered data related to sex, age, FIM total score at admission, FIM total score at discharge, FIM change score (gain or decrease), and length of stay. Significant results from Scheffé multiple comparison tests revealed that patients in group 1 (63 ± 10 years) were significantly older than those in group 2 (56 ± 10 years) or group 3 (53 ± 12 years). Group 2 showed greater FIM gains (37 ± 17) than group 3 or group 1. Ultimately, this study showed that moderately affected patients at admission will show significantly higher FIM gains than severely or mildly affected patients at admission.

Strasser et al., 2008

Strasser et al. evaluated whether a team training intervention in stroke rehabilitation is associated with improved outcomes in patients with stroke [12]. A total of 1,688 patients poststroke (mean age 66 years) was included in the study; all were treated in VA inpatient and

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subacute rehabilitation units. A total of 237 clinic staff on 16 control teams and 227 staff on 15 intervention teams were also included. The study measured three outcomes: functional improvement as measured by FIM motor scores, community discharge, and length of stay. Statistical analysis was performed with use of cluster-adjusted chi-square and *t*-tests. Hierarchical generalized linear models were used to assess the effectiveness on intervention on the three outcomes with the percentage of stroke patients gaining more than 23 points on FIM in the intervention group. A 13.6 percent difference in increase was noted between the control group and the intervention group ($p = 0.032$).

Tur et al., 2003

The purpose of Tur et al.'s retrospective study was threefold: to evaluate the effectiveness of inpatient stroke rehabilitation, examine the relationship between the clinical characteristics of strokes and functional outcomes, and determine what factors predict outcomes at discharge [13]. Data from 102 first-stroke patients (mean age 61.6 years, mean length of stay 69.7 days) were analyzed. FIM data were gathered at admission (mean score 69.2 ± 27.4) and discharge (mean score 83.2 ± 25.7). Patients received physical and occupational therapy for 40 to 60 minutes a day during weekdays; speech and psychological therapy were provided as needed. The results of the statistical analysis revealed that the mean FIM total score was significantly related to age, length of stay, and motor recovery and was the strongest predictor of FIM total score at discharge.

RESULTS

Of the 18 studies that satisfied the inclusion criteria, only 6 were considered high quality based on their PEDro scores. Data from the remaining 12 low-quality studies were excluded from this review. Strasser et al. was the only study that was an RCT and had blinding of all subjects [12]. The remaining five studies were cohort studies; however, all studies presented with study groups that were similar at baseline in regard to their most important prognostic indicators (**Table 2**). Four studies excluded subjects who had a history of a previous stroke. One study limited its inclusion criteria to only subjects who presented with ischemic stroke diagnoses. All studies consisted of both male and female subjects ranging in age from 61.6 to 80.8 years. Study size varied from 102 to 579 subjects. Two studies addressed reliability. Hsueh et al. found FIM to have a Cronbach

alpha on admission of 0.88 and on discharge of 0.91 [8]. Tur et al. reported correlations between admission FIM score and age (–0.28) and length of stay (–0.39) [13]. Furthermore, correlations were reported between discharge FIM score and age (–0.35) and length of stay (–0.50) (**Table 4**).

Three studies addressed validity. Inouye et al. [11] and Tur et al. [13] found FIM to have predictive validity. Hsueh et al. reported the correlations (r_s ≥0.92) and agreement intraclass correlation coefficients between the FIM motor and the 10-item BI were high at admission and discharge, indicating high concurrent validity (**Table 4**) [8].

Black et al. reported that a discharge FIM score of >80 resulted in a sensitivity of 94 percent and a discharge FIM score of >85 resulted in a sensitivity of 88 percent [10]. Furthermore, a discharge FIM score of <75 resulted in a specificity of 59 percent, a discharge FIM score of <80 resulted in a specificity of 65 percent, and a discharge FIM score of <85 resulted in a specificity of 79 percent. (**Table 5**). This study reported that FIM scores at admission and discharge and change in FIM scores were significantly different between patients discharged home and patients discharged to an SNF ($p < 0.001$). Finally, admission FIM scores (global and domain scores) were the most powerful predictors of outcome for stroke patients (Beta coefficient = 0.80 and $p = 0.0000$), explaining 74 percent of its variability ($R^2 = 0.740$), with FIM cognitive scores being the largest contributor at 59 percent ($R^2 = 0.590$) (**Table 6**).

The rankings of the 18 studies according to the PEDro scale and levels of evidence are located in **Table 1**. The six studies under review had a quality score of high and a level of evidence of either 1b or 2b.

All six studies specified eligibility criteria for subjects entering the study, had groups that were similar at baseline in regard to having at least one important prognostic indicator, and provided measures of variability for a minimum of one key outcome measure. The six studies used the FIM as a key outcome measure.

Only the Strasser et al. study [12] received a score of 10/10 on the PEDro scale and presented with a level of evidence of 1b [14].This study had random allocation of subjects, allocation concealment, and blinding of both the patients and therapists. The other five were cohort studies of poststroke patients. These studies scored either a 5 [9–11,13] or 6 [8] on the PEDro scale. All these cohort studies had a level of evidence of 2b or greater. None of these cohort studies presented with random allocation of subjects, allocation concealment, or blinding of subjects. One of these studies

Table 4.
Reliability and validity results.

Author	Reliability	Validity
Black et al., 1999 [1]	NS	NS
Denti et al., 2008 [2]	NS	NS
Hsueh et al., 2002 [3]	Acceptable internal consistency: CCA ≥0.71. CCA: FIM admission = 0.88, discharge = 0.91; BI admission = 0.84, discharge = 0.85; BI-5 admission = 0.71, discharge = 0.	Correlations rest ≥0.92 & agreement ICC between FIM motor & 10-item BI were high at admission & discharge, indicating high concurrent validity. BI-5: poor to fair concurrent validity at admission (r_s = 0.74, ICC ≤0.55) & fair to high validity at discharge (r_s ≥0.92, ICC ≥0.74).
Inouye et al., 2001 [4]	NS	Predictive validity.
Strasser et al., 2008 [5]	NS	NS
Tur et al., 2003 [6]	Correlations between FIM admission score & age = –0.28, LOS = –0.39, BMRS-UE = 0.62, BMRS-LE = 0.57, BMRS-H = 0.53, BMRS-UE discharge = 0.68, BMRS-LE discharge = 0.69, BMRS-H discharge = 0.51. Correlations between FIM discharge score & age = –0.35, LOS = –0.50, BMRS-UE = 0.61, BMRS-LE = 0.64, BMRS-H = 0.52, BMRS-UE discharge = 0.72, BMRS-LW = 0.69, BMRS-H discharge = 0.56.	Predictive validity.

1. Black TM, Soltis T, Bartlett C. Using the Functional Independence Measure instrument to predict stroke rehabilitation outcomes. Rehabil Nurs. 1999:24(3):109–14, 121. [PMID: 10754896]
2. Denti L, Agosti M, Franceschini M. Outcome predictors of rehabilitation for first stroke in the elderly. Eur J Phys Rehabil Med. 2008;44(1):3–11. [PMID: 18385622]
3. 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(2):188–90. [PMID: 12122181]
   DOI:10.1136/jnnp.73.2.188
4. Inouye M, Hashimoto H, Mio T, Sumino K. Influence of admission functional status on functional change after stroke rehabilitation. Am J Phys Med Rehabil. 2001;80(2):121–25. [PMID: 11212012]
   DOI:10.1097/00002060-200102000-00008
5. Strasser DC, Falconer JA, Stevens AB, Uomoto JM, Herrin J, Bowen SE, Burridge AB. Team training and stroke rehabilitation outcomes: A cluster randomized trial. Arch Phys Med Rehabil. 2008;89(1):10–15. [PMID: 18164324]
   DOI:10.1016/j.apmr.2007.08.127
6. Tur BS, Gursel YK, Yavuzer G, Kucukdeveci A, Arasil T. Rehabilitation outcome of Turkish stroke patients: In a team approach setting. Int J Rehabil Res. 2003; 26(4):271–77. [PMID: 14634361]
   DOI:10.1097/00004356-200312000-00004

BI = Barthel Index, BI-5 = 5-item BI, BMRS = Brunnstrom's Motor Recovery Stage, BMRS-H = BMRS-hand, BMRS-LE = BMRS-lower extremity, BMRS-UE = BMRS-upper extremity, CCA = Cronbach coefficient alpha, FIM = Functional Independence Measure, ICC = intraclass correlation coefficient, LOS = length of stay, NS = not studied.

(Hsueh et al., 2002 [8]) blinded the therapists. Descriptions of the subjects and inclusion and exclusion criteria are located in **Tables 2** and **3**.

DISCUSSION

Eighteen studies met our inclusion criteria, of which only six scored 5 or higher on the PEDro scale. These six studies were considered "high" quality and included RCTs and cohort studies. The 12 studies scoring less than 5 were not used because of poor methodological quality [15–26]. All studies were assessed using the Oxford Cen-

tre for Evidence-based Medicine Levels of Evidence (2001) criteria [14]. All reviewed studies were rated level 1b or 2b. Although the FIM has been widely used for a variety of pathologies for more than 20 years, we believe this systematic review may provide useful insight into its use given the availability of recent studies utilizing large study populations. The goal of our systemic review was to investigate the usefulness of the FIM in predicting functional outcomes across varied populations of stroke survivors (retired military persons, civilians, and those in other countries).

Several methodological concerns were identified during the review process. A "stroke"-specific population

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Table 5.
Sensitivity and specificity results.

Author	Sensitivity	Specificity
Black et al., 1999 [1]	Discharge FIM score >80 resulted in 94% sensitivity, which means that of total patients who were discharged home, 94% had discharge FIM score >80. Discharge FIM score >75 resulted in sensitivity of 94%. Discharge FIM score >85 resulted in sensitivity of 88%.	Discharge FIM score <80 resulted in 65% specificity, which means of total patients who did not go home & were transferred to SNF, 65% had discharge FIM score <80. Discharge FIM score <75 resulted in specificity of 59%. Discharge FIM score <85 resulted in specificity of 79%.
Denti et al., 2008 [2]	NS	NS
Hsueh et al., 2002 [3]	NS	NS
Inouye et al., 2001 [4]	NS	NS
Strasser et al., 2008 [5]	NS	NS
Tur et al., 2003 [6]	NS	NS

1. Black TM, Soltis T, Bartlett C. Using the Functional Independence Measure instrument to predict stroke rehabilitation outcomes. Rehabil Nurs. 1999:24(3):109–14, 121. [PMID: 10754896]
2. Denti L, Agosti M, Franceschini M. Outcome predictors of rehabilitation for first stroke in the elderly. Eur J Phys Rehabil Med. 2008;44(1):3–11. [PMID: 18385622]
3. 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(2):188–90. [PMID: 12122181]
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4. Inouye M, Hashimoto H, Mio T, Sumino K. Influence of admission functional status on functional change after stroke rehabilitation. Am J Phys Med Rehabil. 2001;80(2):121–25. [PMID: 11212012]
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5. Strasser DC, Falconer JA, Stevens AB, Uomoto JM, Herrin J, Bowen SE, Burridge AB. Team training and stroke rehabilitation outcomes: A cluster randomized trial. Arch Phys Med Rehabil. 2008;89(1):10–15. [PMID: 18164324]
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6. Tur BS, Gursel YK, Yavuzer G, Kucukdeveci A, Arasil T. Rehabilitation outcome of Turkish stroke patients: In a team approach setting. Int J Rehabil Res. 2003; 26(4):271–77. [PMID: 14634361]
   DOI:10.1097/00004356-200312000-00004

FIM = Functional Independence Measure, NS = not studied, SNF = skilled nursing facility.

(hemorrhagic or ischemic) was utilized for this review. Given the wide variety of potential vascular defects, including location and severity, it is difficult to report with confidence that the studied population was truly homogenous. Most studies included subjects who had experienced their first infarction, were admitted to rehabilitation centers within the first 3 to 6 months, and had no medical complications during the course of rehabilitation. However, the studies did not provide baseline data to allow for predictive validity of the FIM in its application to prognosis or outcomes. We also found that most studies did not mention staff training to ensure standardization of scoring criteria, which could result in significant error due to poor interrater reliability. Multiple scales were encountered during the review, including the BI, the BI-5, the Rehab Factor score, and the MRScale, in addition to the FIM. Considering the amount of available outcome measures employed, the criterion-related validity of the FIM could not be established because of the lack of a widely accepted gold standard test. Lastly, two of the six included studies only used the motor portion of the FIM, which calls into question the construct

validity or the soundness of generalizing the results of the research to validate the FIM outcome tool as a whole.

Our review was subject to several potential biases. Ultimately, the reviewers encountered a dearth of high quality RCTs. To allow systematic data extrapolation, we felt that articles not readily available in full-text online form should be excluded. This may have resulted in exclusion of additional research that would have otherwise been appropriate for review. In addition, including in our review specific search terms such as "Prognosis," "Discharge Placement or Disposition" and/or "Community Function" may have enabled further studies to collaborate the best indicators of the FIM for optimal outcomes. To further refine our search, we could have added to our exclusion criteria those studies that did not elaborate on outcomes of rehabilitation.

Of the included studies, we found that two (Hsueh et al. [8] and Strasser et al. [12]) produced the highest PEDro scores (6 and 10, respectively) and did not focus on prognosis or functional outcomes. Hsueh et al. studied the reliability and validity of comparing outcomes on the FIM

Table 6.
Discharge disposition/predictors.

Author	Home		SNF		FIM Score (Notes)
	%	**Predictors**	**%**	**Predictors**	
Black et al., 1999 [1]	30	<80 FIM score. <70 yr old, $p = 0.01$. <15 d LOS, $p = 0.02$. 20% family worked.	70	>80 FIM score. >70 years old. >15 day LOS. 65% family worked.	Admission, discharge, & change in FIM value ($p < 0.0001$) significantly different in both.
Denti et al., 2008 [2]	79.9	Admission FIM (beta coefficient = 0.80, $p = 0.0000$). FIM cognitive portion (59% contribution $R^2 = 0.590$).	NS	NS	FIM total & motor portion did not contribute to outcome.
Tur et al., 2003 [3]	NS	NS	NS	NS	Predictor variables—age, LOS, onset to admission interval, & FIM total score—all except LOS were related to FIM at discharge.

1. Black TM, Soltis T, Bartlett C. Using the Functional Independence Measure instrument to predict stroke rehabilitation outcomes. Rehabil Nurs. 1999:24(3):109–14, 121. [PMID: 10754896]
2. Denti L, Agosti M, Franceschini M. Outcome predictors of rehabilitation for first stroke in the elderly. Eur J Phys Rehabil Med. 2008;44(1):3–11. [PMID: 18385622]
3. Tur BS, Gursel YK, Yavuzer G, Kucukdeveci A, Arasil T. Rehabilitation outcome of Turkish stroke patients: In a team approach setting. Int J Rehabil Res. 2003; 26(4):271–77. [PMID: 14634361] DOI:10.1097/00004356-200312000-00004

FIM = Functional Independence Measure, LOS = length of stay, NS = not studied, SNF = skilled nursing facility.

with other measures of functional mobility, specifically the BI (the standard 10-item as well as the BI-5). They found that the motor portion of the FIM has high internal consistency when compared with the BI and both measure improvements over time. Strasser et al. was the only study that provided true blinding of subjects in the intervention and control groups. These researchers focused on the effect of staff/stroke team specific training (intervention group) versus no specific training (control group) on outcome measures, including FIM scores and length of stay.

The remaining studies [9–11,13] found that outcomes for stroke, including functional ability, discharge FIM scores, and discharge disposition, were best predicted by admission total FIM score and age (Black et al. [10] FIM <80 and age <70 years; Inouye et al. [11] FIM 37–72 and age 64 ± 11 years; Tur et al. [13] admission FIM score 69.2 ± 27.4 and age 61.6 ± 10.9 years; Denti et al. [9] admission FIM score 55.8 ± 24 and age 80.8 ± 4.7 years). The Tur et al. study also noted onset to admission of rehabilitation center related to discharge FIM scores. Denti et al. divided the admission FIM into its relative parts, including the cognition and motor portions. The researchers found that the cognitive portion of the FIM was the greatest contribu-

tor to discharge disposition. They also found a correlation between a 1-point increase on the MMSE and a 3-percent increase in FIM cognition scores (**Table 7**).

Our systematic review revealed several research articles across varied populations that used the FIM as an accurate predictor of outcomes in patients with stroke. Suggestions for future research include standardization of FIM training to improve interrater reliability, establishment of FIM data in a demographically similar group of unaffected nondisabled subjects to better illustrate pre- and post-CVA disability, and performance of further studies on the usefulness of the total FIM score versus the independent FIM cognition and motor scores (**Table 7**).

CONCLUSIONS

Implications for Practice

Although limited, evidence exists that FIM scores can be used to accurately predict outcomes in patients post-stroke across civilian and veteran populations. Because of its narrow search criteria, this systematic review produced limited articles for review, and of those, even fewer were

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Table 7.
Other psychometrics.

Author	Other Psychometrics
Denti et al., 2008 [1]	FIM scores increased 35.7% after rehabilitation (55.8 ± 24.0 to 75.3 ± 30.0).
	Admission FIM score is also most powerful predictor of MRFS, accounting for 30% ($R^2 = 0.302$) of total MRFS with FIM cognitive score contributing 28% ($R^2 = 0.281$).
	Age is inversely related to rehabilitation efficacy for both FIM & MRFS. Beta coefficient = –0.09 & –0.16, $p = 0.0001$ & 0.0000. Age contributes 1.3% ($R^2 = 0.013$) & 3.6% ($R^2 = 0.036$) to variability of both FIM total discharge score & MRFS.
	Living with family explained 10% of odds of being discharged home in both models using total score & model using domain scores (Nagelkerke $R^2 = 0.108$) with 95% confidence interval.
	Cognitive impairment is independent predictor of home discharge with 6% increase of probability for any 1-point increase in Mini-Mental State Examination (MMSE) score. FIM cognitive score accounted for 3%, independent of MMSE.
Hsueh et al., 2002 [2]	The 3 disability measures were highly responsive to detecting change in performance of activities of daily living during hospital stay. $R \geq 0.75$, $p < 0.001$.
	FIM and Barthel Index are both acceptable for use with patients with stroke during hospital rehabilitation.
Inouye et al., 2001 [3]	Scheffé multiple comparison test showed that patient group with FIM total scores at admission of >73 points were significantly younger (58 ± 11 yr) than patient groups with FIM total scores at admission of 37–72 (64 ± 11 yr) or ≤ 36 (66 ± 12 yr).
	Patient group with FIM total scores of 37–72 at admission showed significantly higher FIM gains (37 ± 15) than patient groups with FIM total scores at admission of ≤ 73 (20 ± 10) or ≤ 36 (29 ± 23).
	No significant differences were found in onset to admission interval & length of hospital stay.
Strasser et al., 2008 [4]	No significant differences ($p > 0.10$) between the demographic characteristics of control & intervention groups.
	No significant differences ($p > 0.10$) between length of stay or rates of discharge to home/community for control & intervention groups.
	Significant difference was noted in FIM motor scores for stroke-only intervention group & stroke-only control group, with intervention group gaining more than median FIM gain of 23 points (difference in increase, 13.6%, $p = 0.032$).
	Intervention group showed significantly greater improvement in FIM motor scores than control group for all patients (6.1%, $p = 0.029$).

1. Denti L, Agosti M, Franceschini M. Outcome predictors of rehabilitation for first stroke in the elderly. Eur J Phys Rehabil Med. 2008;44(1):3–11. [PMID: 18385622]
2. 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(2):188–90. [PMID: 12122181]
   DOI:10.1136/jnnp.73.2.188
3. Inouye M, Hashimoto H, Mio T, Sumino K. Influence of admission functional status on functional change after stroke rehabilitation. Am J Phys Med Rehabil. 2001;80(2):121–25. [PMID: 11212012]
   DOI:10.1097/00002060-200102000-00008
4. Strasser DC, Falconer JA, Stevens AB, Uomoto JM, Herrin J, Bowen SE, Burridge AB. Team training and stroke rehabilitation outcomes: A cluster randomized trial. Arch Phys Med Rehabil. 2008;89(1):10–15. [PMID: 18164324]
   DOI:10.1016/j.apmr.2007.08.127

FIM = Functional Independence Measure, MRFS = Montebello Rehabilitation Factor Score.

considered to be of high quality. If additional research clinical trials support this evidence, rehabilitation practice patterns could be focused on the specific measures identified to improve outcomes of patients poststroke.

Implications for Research

A need clearly exists for well-developed research clinical trials examining the use of FIM scores in predicting functional outcomes. Future studies could be expanded to include other populations for which FIM scores are recorded, such as persons with amputations or traumatic brain injuries. This could be further studied to examine specific populations within a certain demographic criteria (i.e., sex, age, socioeconomic status). As mentioned, comparison studies between nondisabled subjects should be considered. The size of the studies should be large enough to determine

a clinically relevant difference between study groups and should provide a valid and reliable outcome measure.

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