Ms Lynn Kesselring, M.I.E.M.S.S. Editorial staff. FYI/Thanks! JPGF

Functional Screening of Lower-Limb Amputees: A Role in Predicting Rehabilitation Outcome?

Lee Muecke, MD, Sam Shekar, MD, Diane Dwyer, MD, Ebenezer Israel, MD, James P. G. Flynn, MD

ABSTRACT. Muecke L, Shekar S, Dwyer D, Israel E, Flynn JPG. Functional screening of lower-limb amputees: A role in predicting rehabilitation outcome? Arch Phys Med Rehabil 1992;73:851-8.

• The Functional Independence Measure (FIM), a single-score instrument used to measure independent functioning in six areas of basic self-care skills, was used to evaluate 68 patients following lower-limb amputation. Patients in a rehabilitation hospital were assessed with the FIM upon admission and discharge. Admission scores averaged 52.7, ranging from 25.2 to 70.0. Patients scoring in the lowest and highest quartiles were compared: no remarkable gender, ethnic, or age differences were evident. Persons with the lowest scores (ie, lowest functioning) had a higher prevalence of hypertension, coronary artery disease, and noninsulin-dependent diabetes mellitus. The success of rehabilitation in patients in the lower two quartiles upon admission was variable and not predicted well by the FIM. In contrast, predictability of rehabilitation success was high in patients functioning higher at admission, the majority achieving near-perfect scores by discharge. Length of hospitalization appeared to be largely unrelated to the net difference in FIM scores over the course of hospitalization.

KEY WORDS: Amputation, Disability evaluation, Physical disability, Rehabilitation

Medical care required by persons with chronic disabilities is a major component of health care expenditures.[1] Rehabilitation accounts for a significant portion of in-patient care delivered to persons disabled by a variety of conditions. With issues of resource allocation an ever-present concern in modern medicine, subsets of patients who will benefit most from medical interventions should be identified. This reality is especially apparent in the chronic care required in the rehabilitation of patients with lower-limb amputation, most often resulting from diabetes mellitus when nontraumatic.[2] These patients frequently require extensive rehabilitation in addition to the medical care associated with their diabetic complications.[3]

This report describes the demographics of a series of postamputation rehabilitation patients and evaluates the utility of the Functional Independence Measure (FIM)[4] in predicting the success of rehabilitation during the course of admission. The FIM was developed by a national task force as an instrument appropriate for measuring the progress of rehabilitation in patients with multiple disabilities.[5] Still in the process of being fully validated and refined,[4] the FIM was derived from a widely used instrument in physical medicine, the Barthel Index.[6] The FIM provides a more comprehensive and detailed evaluation of rehabilitation patients than does the Barthel Index.[4]

The use of the FIM to evaluate rehabilitation progress in postamputation patients represents a new frontier in the application of this single-score instrument designed to measure rehabilitation success in a variety of disabling conditions. Evaluation thus far has mostly focused on rehabilitation of patients following stroke, the most common admission diagnosis in rehabilitation hospitals,[7] or spinal cord injury.[5] We located no published evaluation of the FIM in postamputation rehabilitation, although we did find two previous efforts to evaluate variables associated with outcome following lower-limb amputation. The first study[8] used multiple regression to determine that age and final level of amputation at last operation were the most significant predictors of outcome.[8] However, this study limited evaluation of outcome to the degree of ambulation and did not use a validated instrument. A second, more recent study[9] performed a retrospective analysis of 97 veteran amputees using multiple regression techniques. Outcome was assessed at an average of 15 months after surgery and included ambulation or wheelchair mobility for a 20-ft distance, the Katz Activities of Living scale, and additional measures of a more subjective nature. This study showed that regression variables best explaining dependence in functioning included high level of amputation, older age, institutionalization, stump pain, confusion, and a poor perception of one's own health.[9]

We undertook a retrospective evaluation of postamputa-

From the Department of Epidemiology and Preventive Medicine (Dr. Muecke), University of Maryland at Baltimore; the Epidemiology and Disease Control Program (Drs. Dwyer and Israel), Maryland Department of Health and Mental Hygiene; the Division of Field Epidemiology (Dr. Shekar), Epidemiology Program Office, Centers for Disease Control, Atlanta, Georgia; and, the Maryland Institute for Emergency Medical Services Systems (Dr. Flynn).

Submitted for publication May 17, 1991. Accepted in revised form October 15, 1991.

No commercial party having a direct or indirect interest in the subject matter of this article has conferred or will confer a benefit upon the authors or upon any organization with which the authors are associated.

Correspondence to Lee Muecke, MD, Department of Epidemiology and Preventive Medicine, University of Maryland at Baltimore, 660 West Redwood Street, Baltimore, MD 21201-1595.

0003-9993/92/7300042$3.00/0

tion rehabilitation patients who had received a FIM assessment on admission and discharge as part of routine inpatient evaluation.

METHODS

Sample

All patients (n = 68) who were admitted to and discharged from Montebello Rehabilitation Hospital (Baltimore, MD) between January 1987 and March 1989 following a nontraumatic lower-limb amputation were evaluated. Only one patient admitted during the study period died during the course of admission and was excluded from our study sample.

Functional Independence Measure Instrument

The FIM (fig 1) is an assessment of six areas of functioning: Self Care, Sphincter Control, Mobility, Locomotion, Communication, and Social Cognition. Each of these areas includes two to six specific skills that contribute to each particular area of functioning, making a total of 18 skills evaluated overall. The skills in the six areas of functioning are scored by different disciplines, including Nursing (eg, "feeding" and "toileting"), Occupational Therapy (eg, "dressing-upper body"), and Physical Therapy (eg, "walk/wheel chair").

Each skill is scored using seven levels of functioning, which range from Complete Dependence to Complete Independence. The FIM is the sum of these scores. Our study used the 1986 version of the FIM scale, which used a four-point scale where each scale can range from a minimum of 0.5 to a maximum of 4.0. (Since January 1, 1988, a revised scale using seven points for the seven levels of functioning has been widely instituted; thus, to avoid confusion, the reader should note this difference when comparing absolute scores from our study with current FIM scores in clinical practice). Using our four-point scales, scores could range from 9 (Complete Dependence) to 72 (Complete Independence). Each skill can be scored at three points in time: on admission, discharge, and follow-up. The hospital did not routinely determine follow-up FIM because of manpower limitations. Our study assessed FIM scores only for the first admission and the last discharge during the study period. Patients with two or more admissions during the study period were assessed using their initial FIM score upon admission and their last discharge FIM score during the study period. The difference between the two scores, the Difference FIM score, served as an outcome measure in our study. In addition to the FIM, demographic and medical information was obtained through chart review for use in our study.

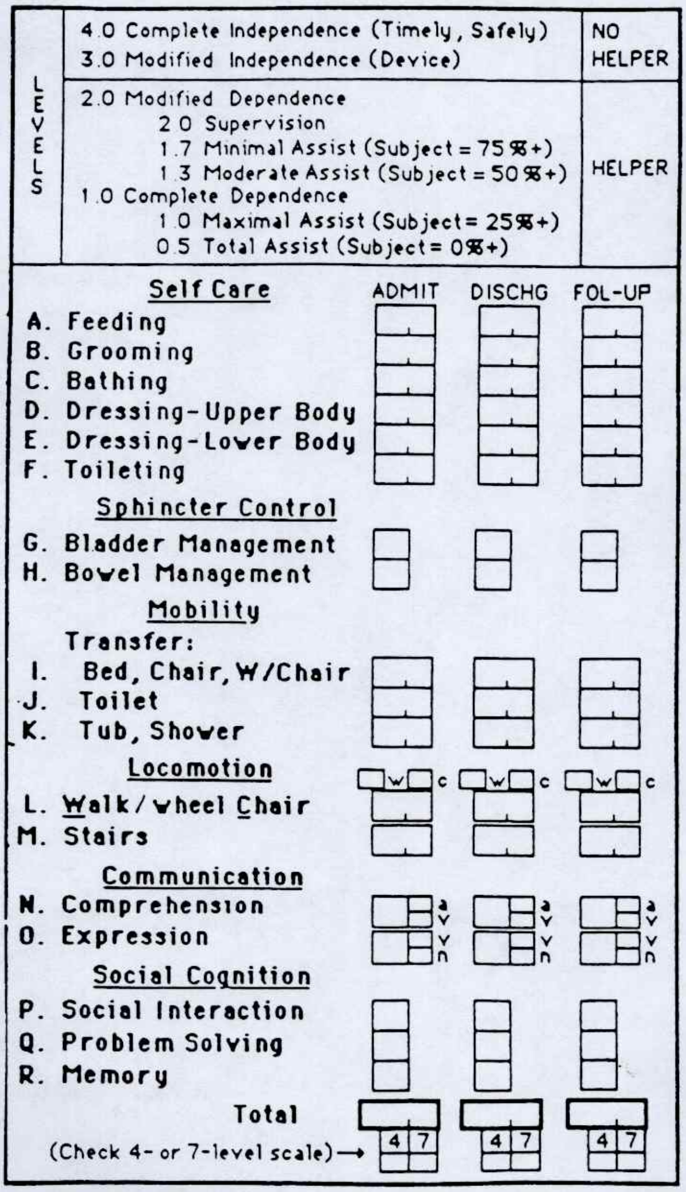

Fig 1—The Functional Independence Measure (FIM) Instrument.

ANALYSIS

Patients were first evaluated by use of descriptive statistics in order to characterize this population and determine distribution of variables potentially related to patient outcome. The patient population was divided into quartiles by their Admission FIM score and evaluated by comparing the first quartile (n = 17) (ie, lowest score; most dependent) with the fourth quartile (n = 17) (ie, highest score; most independent) and looking at differences among several variables. A scattergram of Admission FIM scores and corresponding Difference FIM scores (the last Discharge FIM minus the first Admission FIM score) was plotted to elucidate the relation between these two scores.

To evaluate the specific skills measured by the FIM that specifically related directly to ambulation, we undertook a subanalysis of the 18 skills that constitute the FIM score. We hypothesized that for nontraumatic, lower-limb amputations, both the degree of impairment and subsequent improvement would be uniformly greater for all patients in the areas of functioning measured by the "Amputation FIM" subscore. Conversely, we hypothesized that the "All Other Skills" subscore, being primarily less related to ambulation, would be more variable on admission, and possibly less likely to improve during the admission(s) depending on the underlying cause of the impairments.

In this regard, the Admission, Discharge, and Difference

FIM scores were divided into two components: an Amputation FIM subscore and an All Other Skills subscore. The Amputation FIM subscore was the sum of the scores on eight skills that we deemed heavily associated with the ability to ambulate: transferring from bed to chair, transferring to a toilet, transferring to a tub/shower, walking, climbing stairs, bathing self, using the toilet, and dressing one's lower body. The Amputation FIM subscore could range from a low of 4 to a high of 32. The All Other Skills subscore was the sum of the remaining 10 skills in the FIM, which we deemed to be less associated with ambulation and included skills of communication, social cognition; and self care such as feeding, grooming, and dressing one's upper body. This subscore had a possible range from a low of 5 to a high of 40.

χ^2 contingency tables were used to evaluate independence among categorical variables, whereas two-sample t tests were used to test for significant differences of means of continuous variables (for which standard deviation is indicated), both calculated using a Stat-sak statistical software program (version 2.14, 1985, 1986). Correlation coefficients were generated using SAS statistical software (version 3.0).

RESULTS

Demographics

Table 1 shows the characteristics of the patient population. Some response categories are not listed in table 1; thus, the percentages for some variables do not total 100%. Our patient population consisted of 35 (51.5%) men and 33 (48.5%) women with a median age of 63.5 years. Nearly one-third (32.4%) were married, one-fifth (20.6%) were single, and the remainder divorced (19.1%) or widowed (26.5%). The majority of patients were black (73.5%). Almost one-third (30.9%) reported having no schooling beyond the seventh grade, whereas more than half (54.4%) had eight to 12 years of formal education. Employment status consisted of a large majority of retirees due to age (39.7%) or disability (29.4%); 16.2% reported being unemployed and only 1.5% currently employed. In regard to smoking history, 35.3% were nonsmokers, 27.9% were previous smokers, and 30.9% current smokers. Only 19.1% admitted to a current or past alcohol abuse. About half of the patients (51.5%) were covered by Medicare, over one-quarter (26.4%) had or expected to have Medical Assistance, and 19.1% were covered by Blue Cross/Blue Shield.

Medical Condition Variables

All patients we studied had experienced a nontraumatic, lower-extremity amputation. Four of these patients received two amputations, bilateral in every case, making a total of 72 lower-limb amputations among the 68 patients. Twenty-five patients (36.8%) received an above-knee amputation, 38 patients (55.9%) received a below-knee amputation, four patients had bilateral amputations (5.9%), and one patient (1.5%) had a partial-foot amputation. Seventeen patients in our sample (25%) had history of a previous lower extremity amputation, only five (7.4% of total) of whom had received previous inpatient rehabilitation.

Comorbidities were common in this population with 30 patients (44.1%) having at least one additional chronic condition. Concurrent medical conditions included insulin-dependent diabetes mellitus in 24 patients (35.3%), non–insulin-dependent diabetes mellitus in 23 patients (33.8%) and peripheral vascular disease in 59 (86.8%). Forty-three patients (63.2%) reported a history of hypertension. One quarter of patients had coronary artery disease. Arthritis and obesity were uncommon, with a prevalence of 8.8% each. In contrast, a history of psychiatric illness was present in 27 patients, 39.7% of our sample population.

Rehabilitation Hospitalization Variables

Of the 68 patients studied, 37 (54.4%) had one admission, 23 (33.8%) had two admissions, 5 (7.4%) had three, and 3 (4.4%) had four admissions (table 2). The mean number of admissions during the study period was 1.6. Median length of stay was 60 days (range, 9 to 243 days) for all patients studied, including those with more than one admission. The average cost of hospitalization (estimated at a rate of $370 per day) was $29,034. Thirty-one (45.6%) of these patients were referred from the University of Maryland, one patient (1.5%) from Johns Hopkins Hospital, and 31 (45.6%) from other Maryland hospitals.

Differences Between First and Fourth Quartiles

The mean admission FIM score for all participants was 52.7 (table 3). Overall, this represents a mean score of 2.9 for each skill in the subset of 18 skills assessed by the FIM, placing the mean score for each skill just below 3.0, "Modified Independence" on the four-point (seven-level) FIM scale used.

In light of our limited sample size, we chose to optimize the possibility of detecting real differences by comparing the quartile of patients scoring highest on the FIM upon admission, with the patients in the lowest FIM quartile. This technique was used to, effectively, maximize the sensitivity of the FIM score to the variables under study. However, because relationships between FIM quartile and the other variables studied cannot simply be assumed linear, data on all of the four quartiles are presented (tables 1-3).

The mean admission FIM score of the fourth quartile was 65.9 (range, 61.5 to 70.0; median, 65.5) whereas the first quartile showed a mean of 35.5 (range, 25.2 to 44.2; median, 36.9). Demographics of the two groups showed nominal gender differences and no remarkable ethnic or age differences (table 1). Both groups were equally likely to reside in Baltimore City (88.2%). Persons in the first quartile group were more likely to be married (41.2%) and live with family or relatives (58.8%) than those in the fourth quartile (23.5%, [$p = .27$] and 35.3% [$p = .17$], respectively). No notable differences were present in level of education, smoking history, or alcohol consumption between these groups.

Variables related to medical condition showed subjects in the first quartile to have a higher percentage of hypertension than did those in the fourth quartile (70.6% vs 41.2%, p

Table 1: Demographic Characteristics of 68 Patients With Lower-Limb Amputation Classified by Quartiles According to Functional Independence Measure (FIM) Score on Admission

Characteristic	Total $n = 68$		Admission FIM Quartiles			
			Q1 $n = 17$	Q2 $n = 17$	Q3 $n = 17$	Q4 $n = 17$
	n	%	%	%	%	%
Sex						
Women	33	48.5	35.3	64.7	58.8	35.3
Men	35	51.5	64.7	35.3	41.2	64.7
Race						
Black	50	73.5	70.6	70.6	76.5	76.5
White	18	26.5	29.4	29.4	23.5	23.5
Marital status						
Married	22	32.4	41.2	35.3	29.4	23.5
Widowed	14	20.6	23.5	29.4	29.4	23.5
Divorced	13	19.1	17.6	17.6	17.6	23.5
Single	18	26.5	11.8	17.6	23.5	29.4
Age						
<50	5	7.4	5.9	5.9	11.8	5.9
50-59	22	32.3	41.2	35.3	23.5	29.4
60-69	18	26.5	23.5	35.3	23.5	23.5
70-79	17	25.0	23.5	5.9	29.4	41.2
80-89	6	8.8	5.9	17.6	11.8	0.0
Residence						
Baltimore City	58	85.3	88.2	88.2	76.5	88.2
Baltimore County	1	1.5	0.0	0.0	5.9	0.0
Other	9	13.2	11.8	11.8	17.6	11.8
Education						
<8th grade	21	30.9	29.4	29.4	41.2	23.5
8-12	37	54.4	58.8	52.9	35.3	70.6
College	4	5.9	5.9	5.9	5.9	5.9
Unknown	6	8.8	5.9	11.8	17.6	0
Employment						
Retired due to age	27	39.7	41.2	29.4	52.9	35.3
Retired due to disability	20	29.4	11.8	41.2	23.5	41.2
Employed	1	1.5	0	0	0	5.9
Unemployed	11	16.2	0	23.5	17.6	0
Smoking						
Nonsmoker	24	35.3	41.2	47.1	23.5	29.4
Current smoker	21	30.9	23.5	41.2	35.3	23.5
Ex-smoker	19	27.9	29.4	11.8	35.3	35.3
Unknown	4	5.9	5.9	0	5.9	11.8
Alcohol abuse (history)	13	19.1	23.5	17.6	17.6	17.6
Level of Amputation						
Above-Knee	25	36.8	41.2	35.3	29.4	41.2
Below-Knee	38	55.9	41.2	58.8	64.7	58.8
Bilateral	4	5.9	17.6	5.9	0	0
Partial Foot	1	1.5	0	0	5.9	0
Hypertension	43	63.2	70.6	70.6	70.6	41.2
Diabetes						
Insulin-dependent	24	35.3	35.3	47.1	29.4	29.4
Non–insulin-dependent	23	33.8	35.3	35.3	47.1	17.6
Peripheral vascular disease	59	86.8	76.5	94.1	82.4	94.1
Arthritis	6	8.8	11.8	17.6	5.9	0
Obesity	6	8.8	17.6	0	11.8	5.9
Psychiatric	27	39.7	41.2	47.1	23.5	47.1
Coronary artery disease	17	25.0	35.3	23.5	29.4	11.8
Assist devices on admission						
Crutches	36	52.9	17.6	29.4	88.2	76.5
Wheelchair	35	51.5	88.2	64.7	23.5	29.4
Temporary prosthesis	40	5.9	0	0	11.8	11.8
Permanent prosthesis	30	44.1	17.6	23.5	70.6	64.7
Prior amputation	17	25.0	23.5	29.4	29.4	17.6
If yes, prior rehab.	5	7.4	5.9	11.8	5.9	5.9
Insurance						
Medicare	35	51.5	58.8	41.2	76.5	29.4
Medical Assistance	18	26.4	29.4	29.4	11.8	35.3
Blue Cross/Blue Shield	13	19.1	11.8	29.4	5.9	29.4
Other	2	2.9	0	0	5.9	5.9

Functional Independence Measure Score Quartile Cutpoints: Q1 = 25.0 to 44.0, Q2 = 46.0 to 55.2, Q3 = 55.3 to 61.0, Q4 = 62.0 to 70.0.

Table 2: Hospitalization-Related Characteristics of 68 Patients* With Lower-Limb Amputation Classified by Quartiles According to Functional Independence Measure (FIM) Score on Admission

Characteristic	Total $n = 68$		Admission FIM Quartiles Q1 $n = 17$	Q2 $n = 17$	Q3 $n = 17$	Q4 $n = 17$
	n	%	%	%	%	%
Number of admissions						
One	37	54.4	70.6	70.6	41.2	35.3
Two	23	33.8	23.5	23.5	47.1	41.2
Three	50	7.4	0	5.9	5.9	17.6
Four	3	4.4	5.9	0	5.9	5.9
	n	mean (range)	mean	mean	mean	mean
Hospitalization days						
All Patients	68	78.5 (9-243)	52.8	54.6	96.1	110.4
Above-Knee	25	72.6	50.1	42.0	82.4	114.4
Below-Knee	38	87.2	57.9	63.4	108.9	107.6
Bilateral	4	46.0	47.3	42.0	0	0
Partial Foot	1	23.0	0	0	23.0	0
Cost of Hospitalization, mean (range)		$29,034 ($3,330-$89,910)	$19,546	$20,198	$35,542	$40,852
	n	%	%	%	%	%
Discharge destination						
Home	55	80.9	70.6	76.5	82.4	94.1
Board and care	2	2.9	0	5.9	5.9	0
Intermediate care	2	2.9	5.9	5.9	0	0
Skilled nursing	2	2.9	5.9	0	0	5.9
Acute unit-diff. facility	7	10.3	17.6	11.8	11.8	0
Discharged to live:						
Alone	13	19.1	5.9	17.6	23.5	29.4
With family	35	51.5	58.8	47.1	64.7	35.3
With friends	5	7.4	5.9	5.9	0	17.6
With attendant	1	0	0	0	0	5.9
Other	12	17.6	29.4	23.5	11.8	11.8

* Totals may not add to 68, indicating information on this variable was not available for certain individuals.

= 0.08). The same was true for coronary artery disease (35.3% vs 11.8%, $p = .11$). About 35% of those in the first quartile had non–insulin-dependent diabetes mellitus compared to 17.6% ($p = .24$) in the fourth quartile. No significant difference was noted in the history of potentially more serious insulin-dependent diabetes mellitus (first quartile = 35.3% vs fourth quartile = 29.4%).

Members of the fourth quartile were significantly more likely to use crutches on admission than those in the first quartile (76.5% vs 17.6%, $p < .001$) and were significantly more likely to use a permanent prosthesis (64.6% vs 17.6%, $p < .01$). Members of the first quartile were nearly three times as likely to use a wheelchair (88.2%) than were members of the fourth quartile (29.4%, $p < .001$).

Members of the first quartile were twice as likely to be insured with Medicare (58.8%) than the fourth quartile (29.4%); whereas fourth-quartile members were more likely to be covered under Blue Cross/Blue Shield (29.4%) than first-quartile members (11.8%). Despite having higher functioning on admission, those in the fourth quartile had more admissions (1.9 vs 1.4, $p < .08$), a longer mean total hospitalization period (110.4 days vs 52.8 days, $p < .0001$), and consequently higher cost of hospitalization ($40,852 vs $19,546, $p < .0001$) than those in the first quartile.

The Discharge FIM score was strongly correlated with Admission FIM score (r = .84). Figure 1 shows a scattergram of the difference in FIM score from admission to discharge (Difference FIM = last Discharge FIM − first Admission FIM) plotted as a function of the Admission FIM score. Admission FIM quartiles are noted on the ordinate. The Difference FIM score was negatively correlated with the Admission FIM score (r = −.38); thus, those with a lower Admission FIM score improved more on the average than those who had a higher level of functioning on admission. However, for those in the lower two quartiles, the degree of improvement was highly variable: some improved to maximum independence and others showed no improvement. The tighter clustering of smaller differences in the top two quartiles is explained by the fact that calculation of the Difference FIM score includes the Admission FIM score. Thus, those scoring high on admission cannot improve beyond a FIM of 72, the maximum score, and are thus subject to a "ceiling effect."

Table 3 also shows the results of the analysis of FIM sub-

Table 3: Functional Independence Measure (FIM) Scores* of 68 Patients With Lower-Limb Amputation Classified by Quartiles According to Functional Independence Measure (FIM) Score on Admission

	Total $n = 68$	Admission FIM Quartiles Q1 $n = 17$	Q2 $n = 17$	Q3 $n = 17$	Q4 $n = 17$
Admission FIM score mean					
All Patients	52.7	35.5	51.1	58.1	65.9
Above-knee	51.8	33.7	51.3	58.0	65.9
Below-knee	54.6	37.6	51.4	57.9	65.9
Bilateral	37.9	35.1	46.5	0	0
Partial foot	61.0	0	0	61.8	0
"Amputation FIM" subscore	17.9	9.9	15.4	20.1	26.0
"All Other Skills" subscore	34.8	25.6	35.7	38.0	39.9
Discharge FIM score mean	61.5	47.4	61.5	68.4	68.6
"Amputation FIM" subscore	24.3	16.7	23.4	28.6	28.6
"All Other Skills" subscore	37.1	30.7	38.1	39.7	39.9
Difference FIM score† mean					
All patients	8.8	11.8	10.4	10.2	2.7
Above-knee	8.4	12.9	9.4	10.2	1.8
Below-knee	8.8	11.9	9.9	10.8	3.3
Bilateral	12.3	9.4	21.0	0	0
Partial foot	4.5	0	0	4.5	0
"Amputation FIM" subscore	6.5	6.8	7.9	8.5	2.7
"All Other Skills" subscore	2.3	5.1	2.5	1.8	0.0

* All scores based on a four-point, seven-level FIM score (1986 version). Admission FIM score range for all 68 patients: 25.2 to 70.0. Discharge FIM score range for all 68 patients: 26.2 to 70.0. Difference FIM score range for all 68 patients: −2.1 to 28.4.
† Difference FIM score = Discharge FIM on last admission minus Admission FIM on first admission.

scores. Patients in the fourth quartile of FIM score on admission were fully functional in All Other Skills and remained so on discharge (no improvement needed). Because their Amputation FIM was high and thus their functional impairment minor on admission, they became fully independent with only minor increase in FIM score during an average hospitalization period of 110 days. These patients were more often discharged to home, with almost 30% living alone.

The least functional patients on admission in our study, those in the first quartile, had impairments measured by both low Amputation FIM and low All Other Skills subscores. On the average, these patients made the largest improvement in those skills less related to ambulation (All Other Skills) (table 3) and showed good improvement in ambulation during an average stay of 52.8 days (table 2). Notably, less than 6% of these patients in the first quartile were discharged to situations where they were to live alone. This figure is low relative to the nearly 30% of fourth quartile patients able to live alone, and thus not requiring an assistant, upon discharge. Both figures, however, are markedly low when viewed relative to the total US population ages 65 to 74 years of which 90% live at home "independently,"[1] and require no assistance performing routine daily activities such as dressing, shopping, and light housework.

Level of amputation had a minimal effect on Admission FIM and Difference FIM scores, with below-knee amputations showing a slightly higher score on each score (table 3). Patients with below-knee amputation experienced a longer mean period of hospitalization by approximately two weeks (87.2 days vs 72.6 days).

The role of both length of hospitalization and multiple admissions were evaluated. Those with the highest level of functioning on first admission (Admission FIM quartiles 3 and 4) were more likely to have two or more admissions, and have longer hospital stays than those with lower admission FIM score in quartiles 1 and 2. Table 4 demonstrates the positive association between number of admissions and length of stay broken into 50-day increments. Those with one admission had a mean hospital stay of 62.3 days compared to 88.4 days and 124.8 days among those with two admissions, and three or four, respectively. As noted in table 2, the mean length of hospitalization showed a consistent, stepwise positive association with higher Admission FIM scores over the four quartiles, and ranged from 52.8 days (Quartile 1) to 110.4 days (Quartile 4). Patients in the fourth quartile were more than twice as likely as those in the first quartile to have had two or more admissions.

DISCUSSION

Descriptive analysis of this serial patient population of nontraumatic, lower-limb amputees at the Montebello Re-

Table 4: Total Length of Hospitalization by Number of Admissions Among 68 Patients With Lower-Limb Amputation

Number of Admissions	Length of Hospitalization (Days) <50	50-99	100-149	≥150
One	17	14	5	1
Two	1	12	10	0
Three or four	1	1	4	2

habilitation Hospital revealed that patients were predominantly black and had a median age of 65. Most were diabetic and suffered from peripheral vascular disease. Comorbidities were common at 44% and markedly exceeded the prevalence of two chronic conditions in the general population ages 60 to 69 years (men having 6.3%, women 4.2%).[10] Approximately three fourths were insured by Medicare or Medical Assistance. Nearly 90% of patients resided in Baltimore, indicating this state referral facility is primarily used by residents of Baltimore.

Factors involved in patient admission to and discharge from a rehabilitation hospital, such as insurance coverage, cost, and need for multiple modes of rehabilitation therapy (physical, occupational, speech), may play a significant role in patient management. For example, reimbursement policies may place limits on length of hospitalization.[11] In light of the ever-present need to reduce medical expenditures, an effective method of screening patients prior to rehabilitation hospitalization would enable in-patient rehabilitation facilities to admit those with greatest need and those with greatest potential for improvement. A systematic method to aid in making comparisons of patients could potentially help standardize the process by which certain patients are selected as the "best candidates" for admission. Patients with higher levels of functioning, or those needing only one therapeutic modality, may be equally served by out-patient or day-hospital services at lower cost. Although assessing rehabilitation potential in patients is complex and difficult to quantify, an objective measure could provide a more equitable basis for making decisions regarding admission.[12]

The Admission FIM score was evaluated as a predictor of improvement during hospitalization. Our analysis showed that patients admitted with FIM scores in the lower two quartiles showed more improvement on average, as measured by their Difference FIM, than did those admitted with higher functioning FIM scores in the top two quartiles. The Admission FIM, however, proved to be a poor predictor of which persons in the lower two quartiles would actually show the most improvement in functional status as measured by the FIM. As seen in figure 2, these patients fall

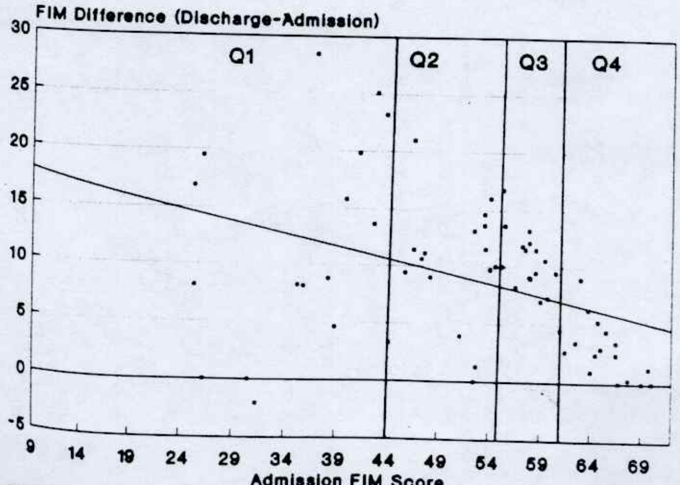

Fig 2.—Admission FIM scores relative to FIM difference scores by quartiles, $n = 68$.

into a visible dichotomy of rehabilitation responders and nonresponders. Efforts to better identify members in this group who respond well to inpatient rehabilitation offers significant potential. Patients with below-knee amputations scored only slightly higher on both Admission FIM and Difference FIM scores, consistent with a similar finding in both studies described above,[8-9] which found a lower-level of lower-extremity amputation to be associated with a higher degree of functioning following lower-limb amputation.

In contrast, the FIM score was highly predictive of rehabilitation success in those scoring in the top two quartiles upon admission. Patients with higher functioning on admission in the third and fourth quartiles had longer hospitalizations and incurred higher costs. The large majority of these patients achieved a near-perfect score by time of discharge. But, because they entered rehabilitation at a higher level of functioning than members of the first two quartiles, they had an inherent limit placed on the amount of change they could achieve—a ceiling effect on their Difference FIM score.

The reason for an increased mean number of admissions and longer stays among patients with higher functioning at time of admission is not apparent. Because multiple admissions was not a specific focus in this study, only speculative comments are warranted. In this regard, we suspect that patients scoring higher upon admission were deemed by their physician as having greater rehabilitation potential than did patients admitted with profound functional impairment. Thus, the clinical goals for each admission were more circumscribed and the patients remained hospitalized until the goals were reached. In contrast, the clinical goals of patients admitted with global deficits and virtually no possibility of living independently upon discharge, may have been lower and achieved in a shorter stay. This premise is supported by the observation that a patient in the fourth quartile, with no functional impairment other than his amputation, was more likely to live alone following discharge (table 2). Other more pragmatic considerations, such as the personal preference of patients or health insurance restrictions, might also play a role in length and number of admissions.

Possession of prostheses at time of admission was much more common among patients in the highest two quartiles. On average, patients in the top two quartiles were more than three times likely to have a permanent prosthesis at time of admission. In addition, all patients admitted with a temporary prosthesis during the study period scored in the upper two quartiles, thus adding support to the premise that higher-functioning patients experienced longer admissions in an effort to perfect their prosthetically-assisted ambulation.

Any attempt to use a screening instrument that measures current level of functioning to predict outcome of rehabilitation is subject to significant limitations. First, it is obvious that those with the highest level of functioning on admission will do best on discharge barring unforeseen setbacks during rehabilitation. Those with the lowest level of functioning might have the greatest capacity to improve; however, functional threshholds may exist that determine the extent of potential rehabilitation success. For example, all wheelchair-bound patients with low Admission FIM scores cannot be assumed good candidates for future ambulation because they may have other limitations (eg, completed stroke, prior amputation) not measured by the FIM alone. Therefore, the potential gains in ambulation may be limited a priori. Second, a relatively simple screening instrument such as the FIM is not proposed as the sole criterion on which to base hospitalization, but it may serve as a valuable component in this decision. Alternative forms of rehabilitation, such as outpatient or nursing-home care, might offer more appropriate management of patients who are admitted with high FIM scores and require only one modality of therapy or patients with low FIM scores when the goal of rehabilitation is not full independence.

CONCLUSIONS

This study used a unique epidemiologic approach to the field of physical medicine and rehabilitation by attempting to screen patients using a survey instrument, the Functional Independence Measure (FIM). Analysis of the FIM score and demographic information provides valuable insights into the characteristics, utilization patterns, and improvements among in-patients at one rehabilitation hospital following nontraumatic, lower-limb amputation. It has also provided preliminary evidence that, among patients admitted for rehabilitation following a lower-limb amputation, the least functional patients as a group benefitted the most from hospitalization and stayed fewer days; however, individual outcomes were highly variable and not predicted well by the FIM on admission. These results need confirmation in large groups of rehabilitation patients. The FIM could possibly be appropriately modified to more specifically evaluate different patient conditions. It appears that a more valid instrument could be tailored to specific disabilities and thus enlarge its role in future research and clinical practice.

Acknowledgments: The authors thank Rheka Garg, MD, MPH, and the staff of Montebello Rehabilitation Hospital (particularly the Medical Records Department) for their assistance with data collection. Thanks is also extended to Lynn Kesselring of the Editorial Staff of the Maryland Institute for Emergency Medical Services Systems for her assistance with manuscript preparation.

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