Key Neurological Impairments Influence Function-Related Group Outcomes After Stroke

Lu Han, MD; Diane Law-Gibson, MS, HAS; Michael Reding, MD

Background and Purpose—The function-related group (FRG) classification is based on functional assessment and has been assumed to encompass the effects of different patterns and severity of neurological impairments. This assumption may not be correct. It has been proposed as a means of comparing rehabilitation outcome across institutions. If neurological impairments significantly affect FRG outcome, then higher FRG outcome scores may reflect selection bias favoring patients with fewer neurological impairments rather than better quality of rehabilitation care. The goal of this study was to assess the influence of motor, somatosensory, and hemianopic visual impairments on FRG outcomes after stroke.

Methods—All 288 consecutive stroke patients discharged in 1999 from an acute rehabilitation hospital were assigned to 1 of 5 FRGs on the basis of their Functional Independence Measure (FIM) mobility subscore and age. Each FRG was also stratified into 1 of 4 cohorts on the basis of the presence or absence of key neurological impairments: motor impairment only (M), motor plus either somatosensory or hemianopic visual impairment (MS/MV), motor plus somatosensory plus hemianopic visual impairment (MSV), and other combinations of impairments. FIM scores were available every 10 days for all patients from admission to discharge. The effect of impairment group on outcome was assessed within each FRG category through repeated-measures analysis of variance to assess differences in serial FIM scores across the 4 impairment groups. The distribution of each of the 4 impairment groups across the 5 FRGs was assessed with $\chi^2$ analysis.

Results—The numbers of patients in each of the 5 FRGs from the lowest level, FRG-11, to the highest, FRG-15, were as follows: 78 (27%), 47 (16%), 75 (26%), 55 (19%), and 33 (11%). Different neurological impairments were associated with significantly different mean±SD discharge FIM scores as follows: for FRG-11, MSV=63±16, MS/MV=68±19, and M=81±13 ($P=0.04$); for FRG-12, MSV=47±14, MS/MV=61±12, and M=75±11 ($P=0.01$); and for FRG-13, MSV=79±20, MS/MV=85±19, and M=96±10 ($P<0.02$). For FRG-14 and FRG-15, those with M impairments had the highest and those with MSV impairments had the lowest discharge FIM scores, but the differences did not reach statistical significance. The $\chi^2$ analysis showed a highly significant difference in representation of MSV impairments across FRG-11 through FRG-15 as follows: 35 of 78 (45%), 20 of 47 (43%), 11 of 74 (15%), 4 of 55 (7%), and 2 of 33 (6%). For patients classified as having an M deficit only or other impairment, the results were as follows: 19 of 78 (24%), 15 of 47 (32%), 41 of 75 (55%), 41 of 55 (75%), and 27 of 33 (82%) ($\chi^2$ analysis=$78.7$, $P<0.0001$).

Conclusions—The presence of motor, somatosensory, and hemianopic visual impairment significantly affects FRG outcome and should be included in future outcome assessment tools. Comparisons of FIM change and efficiency scores across institutions are potentially biased by referral and selection criteria favoring equally dysfunctional but less neurologically impaired individuals. (Stroke. 2002;33:1920-1924.)

Key Words: cerebrovascular disorders ■ neurological deficits ■ outcome assessment ■ recovery of function

There is now an international consensus that acute inpatient rehabilitation decreases 3- and 6-month mortality, improves functional recovery, decreases length of hospital stay, and increases the probability of home instead of skilled nursing home discharge. This has led to an increasing demand for medical and rehabilitation services in the United States, costing an estimated $17 billion per year. There is an obvious need to provide these services as cost-efficiently as possible.

The US Health Care Finance Administration (HCFA) contracted the Research and Development (RAND) Corporation to study rehabilitation hospital practice patterns across the United States. Data are readily available for patients with stroke from the Uniform Data Set for Stroke Rehabilitation. This data bank includes information from 588 participating rehabilitation units across the country. This data set allows analysis of functional outcomes based on clinical demo-
graphic features and severity of stroke as assessed by the Functional Independence Measure (FIM). Several stroke management algorithms have been generated from this data set. Each algorithm has used ≥1 of the following items to define length of rehabilitation hospital stay: FIM mobility subscore, FIM cognition subscore, and age. In 1 such algorithm, shown in Figure 1, patients are categorized into 1 of 5 FRG outcome groups based on age and rehabilitation hospital admission FIM mobility score (sum of the patient’s feeding, dressing, grooming, bathing, toileting, bowel, bladder, walking, transfer, and stair climbing FIM subscores). The length of hospital stay is known for each of these FRGs. From length of stay, one can estimate the cost of care and hence the burden of care (see Figure 1).

Since the HCFA publication of Figure 1, several subsequent FRG-type outcome algorithms have appeared. The most recent version contains 14 stroke case-mix groups (CMGs). CMG categories, like FRG categories, are based on FIM mobility subscores, FIM cognition subscores, and age. It has been shown that neurological impairments also define clinically relevant cohorts with different probabilities of reaching independence with self-care and walking. Figure 2 shows 1 such impairment-based algorithm that uses motor paresis, hemihypesthesia, and hemianopic visual deficits to define outcome cohorts. This figure shows a life-table analysis of the probability of reaching a Barthel Index score of ≥60 for stroke victims with an initial unilateral ischemic hemispheric stroke. A Barthel Index score of ≥60 indicates that the patient can usually be cared for at home by an aged spouse.

None of the HCFA FRG-CMG algorithms include neurological impairments in defining prospective payment out-

![Figure 1. Disability-based FRG stroke outcome groups defined by age and rehabilitation hospital admission FIM Mobility Scores (adapted from References 1 and 3).](image)

![Figure 2. Impairment-based stroke outcome groups defined by the presence of motor, sensory, and visual deficits. (From Reding M, Potes E. Rehabilitation outcome following initial unilateral hemispheric stroke. Stroke. 1988;19:1354–1348. Used with permission of the American Heart Association.)](image)
come cohorts. It has been assumed that stroke-related neurological impairments are encompassed by the FIM self-care, mobility, and cognitive domains. This assumption may not be correct. To test this hypothesis, we decided to compare the outcome of patient cohorts defined by FRG criteria and categorize them on the basis of clinically relevant neurological impairments: hemiparesis, hemihypesthesia, and hemianopic visual deficits. If neurological impairments affect outcome within the defined FRG/CMG categories, then FRG/CMG prospective payment systems will exert financial pressure to select patients free of burdensome hemisensory and hemianopic visual impairments.

**Methods**

The study sample consisted of 288 consecutive patients discharged in 1999 from an acute inpatient stroke rehabilitation unit. The diagnosis of stroke was based on clinical history, neurological examination, and neuroimaging studies. A standardized medical and neurological assessment at the time of rehabilitation hospital admission was recorded in a computerized stroke data bank. This evaluation documented key neurological impairments previously determined to be relevant for stroke outcome prediction: hemiparesis, hemihypesthesia, and hemianopic visual deficits. Motor strength was assessed with the Motricity Index. The Motricity Index was scored for both the upper and lower limbs, with scores ranging from 0 to 100 (normal) for each limb. An upper or lower limb score of <80 was said to indicate hemiparesis. Somatic sensation was scored with the limb placement test. Patients were instructed to touch the index finger of their affected hand with the index finger of their unaffected hand with their eyes closed as the affected hand was displaced randomly by the examiner into all 4 spatial quadrants. A reproducible error of >6 inches in any spatial quadrant was said to indicate a somatic sensory deficit. Patients who were unable to comprehend this test even after repeated gestural cues were scored as abnormal. Previous studies have shown that more patients with aphasia and hemianopic visual deficits were scored by confrontation visual field testing or by visual threat response.

FIM scores were recorded by stroke team members at the time of rehabilitation hospital admission and every 10 days thereafter until the time of discharge. Raters were unaware of the current study hypothesis. Patients were classified into 1 of 5 FRGs as described in HCAF publications on the basis of their FIM mobility subscore and age (see Figure 1). Each FRG was further stratified into 1 of 4 impairment groups based on the presence or absence of key neurological impairments: motor impairment only (M), motor plus somatosensory or hemianopic visual impairment (MS/MV), motor plus somatosensory plus hemianopic visual impairment (MSV), and other combinations of impairments (O). Patients with O impairments did not have significant weakness. Their most paretic limb Motricity Index score was >80. Their primary impairment was usually ataxia, dyspraxia, or impaired static-dynamic standing balance.

The effect of impairment group on outcome was assessed within each FRG category through repeated-measures analysis of variance (ANOVA) to assess differences in serial FIM scores across the 4 impairment groups. The distribution of each of the 4 impairment groups across the 5 FRGs was assessed with $\chi^2$ analysis.

**Results**

Table 1 shows the demographic features of our study sample. These data support the observation that our subjects are similar to those commonly encountered in other acute inpatient stroke rehabilitation units across the country.

Chi-square analysis showed that the representation of neurologic impairment groups differed significantly across the 5 FRG cohorts (Table 2).

Repeated-measures ANOVA was used to compare serial FIM scores across impairment groups within each of the 5 FRG cohorts (Figure 3). There was a significant effect of impairment on mean±SD discharge FIM score for the FRG cohorts as follows: for FRG-11, MSV=63±16, MS/MV=68±19, and M=81±13 ($P=0.04$); for FRG-12, MSV=47±14, MS/MV=61±12, and M=75±11 ($P=0.01$); and for FRG-13, MSV=79±20, MS/MV=85±19, and M=96±10 ($P<0.02$). Similar results were seen for FRG-14 and FRG-15, but the differences did not reach statistical significance. Outcome plots for FRG-11 through FRG-14 are shown in Figure 3.

**Discussion**

The most interesting observation in this study is that key neurological impairments significantly affected discharge

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**Table 1. Demographic Data for 288 Patients With Stroke**

<table>
<thead>
<tr>
<th></th>
<th>FRG-011</th>
<th>FRG-012</th>
<th>FRG-013</th>
<th>FRG-014</th>
<th>FRG-015</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients, n (%)</td>
<td>78 (27)</td>
<td>47 (16)</td>
<td>75 (26)</td>
<td>55 (19)</td>
<td>33 (11)</td>
<td>288 (100)</td>
</tr>
<tr>
<td>Female/male, n</td>
<td>39/39</td>
<td>25/22</td>
<td>43/32</td>
<td>31/24</td>
<td>13/20</td>
<td>151/137</td>
</tr>
<tr>
<td>Mean±SD age, y</td>
<td>67±9</td>
<td>84±4</td>
<td>73±11</td>
<td>72±12</td>
<td>65±13</td>
<td>72±12</td>
</tr>
<tr>
<td>Mean±SD LOS, d</td>
<td>42±16</td>
<td>38±15</td>
<td>33±11</td>
<td>25±8</td>
<td>16±9</td>
<td>33±15</td>
</tr>
</tbody>
</table>

**Table 2. Distribution of Neurological Impairment Groups Across FRG Cohorts**

<table>
<thead>
<tr>
<th></th>
<th>FRG-011, n (%)</th>
<th>FRG-012, n (%)</th>
<th>FRG-013, n (%)</th>
<th>FRG-014, n (%)</th>
<th>FRG-015, n (%)</th>
<th>Total, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>17 (22)</td>
<td>11 (23)</td>
<td>30 (41)</td>
<td>21 (38)</td>
<td>14 (43)</td>
<td>93 (33)</td>
</tr>
<tr>
<td>MS/</td>
<td>24 (31)</td>
<td>12 (26)</td>
<td>23 (31)</td>
<td>10 (18)</td>
<td>4 (12)</td>
<td>73 (25)</td>
</tr>
<tr>
<td>MV</td>
<td>35 (45)</td>
<td>20 (43)</td>
<td>11 (15)</td>
<td>4 (7)</td>
<td>2 (6)</td>
<td>72 (25)</td>
</tr>
<tr>
<td>MSV</td>
<td>2 (2)</td>
<td>4 (8)</td>
<td>10 (13)</td>
<td>20 (37)</td>
<td>13 (39)</td>
<td>48 (17)</td>
</tr>
<tr>
<td>Total*</td>
<td>78</td>
<td>47</td>
<td>74</td>
<td>55</td>
<td>33</td>
<td>287</td>
</tr>
</tbody>
</table>

*Missing data in FRG-13 reduces the total count from 288 to 287 patients.*
FIM performance within each of the lowest 3 FRG categories. The same trend was seen for the 2 highest FRG categories, but the sample size was small and the results did not reach statistical significance. Given these observations, one must question the rationale of FRG-based prospective payment systems.

FRG assignment does not allow ready identification of patients who require additional rehabilitation services. A patient whose FIM score indicates that he or she is in FRG-11 may have a pure motor impairment. Another patient with a similar FIM score may have motor, sensory, and hemianopic visual deficits that have direct implications for outcome and safety awareness. Such patients may need the same amount of physical assistance, but those with additional sensory and visual perception deficits need verbal cues to complete the task and supervision for safety during and between tasks. Both patients are scored on the FIM as needing the same physical assistance, but the need for additional supervision for safety and need for verbal cues is not recorded for lower-level performance. Gait training for the patient with pure motor hemiparesis must address the practical issues of trying to walk with a weak leg. Gait training for the patient with hemiparesis plus hemihypesthesia and hemianopsia must address the effects of leg weakness on walking plus the patient’s impaired awareness of the paretic leg and impaired visual scanning while walking. Occupational therapy will require additional time to address the patient’s impaired awareness of the paretic hand. Such patients require ongoing verbal cues during self range-of-motion exercises to complete the task. Support and protection of the sensory-impaired limb are complicated by the fact that the patient is not aware of limb position and has difficulty protecting it from injury.

The rationale underlying development of the FRG categories was that the functional status of the patient was assumed to encompass the patient’s neurological impairments. The FRG system does not require measurement of strength or sensory function or assessment of visual fields. Such evaluations add to the burden of patient assessment and were thought to be less objective than simply assessing activities of daily living functions. The FRG system based on FIM data can be scored by interviewing the patient or caregiver either in person or over the phone. Although the FRG system based on FIM scores may be easy to use, our data do not support the basic hypothesis that FRG categories adequately represent the burden of care or outcome expectations of patients with motor, sensory, and hemianopic visual impairments.

Our data indicate that patients with different neurological impairments are often assigned to the same FRG category. The greater the number of key neurological systems affected, the less complete the neurological recovery is and the less ability the patient has to use compensatory systems or assist devices to improve self-care function. Use of the FRG system to guide payment for inpatient rehabilitation services will therefore force exclusion of more neurologically impaired patients within each of the FRG categories. Such patients, although they require more time and effort, are still quite acceptable rehabilitation candidates and, as illustrated in Figure 3, can be expected to show a 22-point increase in FIM score. Exclusion of such patients will result in group statistics that show greater changes in FIM scores, greater FIM

Figure 3. Outcome for FRG cohorts based on key neurological impairments. There was a significant effect of impairment on mean discharge FIM score for FRG-11 ($P=0.04$), FRG-12 ($P=0.01$), and FRG-13 ($P=0.02$). Similar results were seen for FRG-14 and FRG-15 (not shown), but the differences did not reach statistical significance. Data were missing for several patients in each impairment group; hence, the sum of the impairment groups does not equal the sum of the FRG groups.
efficiency, and shorter length of inpatient rehabilitation hospital stay. These seeming accomplishments, however, may reflect only a change in screening and admission characteristics. This change in selection criteria will not be captured by existing FRG-FIM data systems because they do not record neurological impairments. Comparison of outcome across institutions requires matching patients for both severity of disability and type of neurological impairments.

Conclusions
The presence of motor, somatosensory, and hemianopic visual impairment significantly affects FRG outcome and should be included in future outcome assessment tools. Comparisons of FIM change and efficiency scores across institutions are potentially biased by referral and selection criteria favoring equally dysfunctional but less neurologically impaired individuals.

Acknowledgment
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References
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