A Comparison of Five Stroke Scales With Measures of Disability, Handicap, and Quality of Life

R. De Haan, MS; J. Horn, MS; M. Limburg, MD, PhD; J. Van Der Meulen, MD, PhD; P. Bossuyt, PhD

Background and Purpose: Recently much debate has arisen on the appropriateness of assessing stroke outcomes with stroke impairment scales. Our purpose was to study the relationship between long-term impairments and functional outcomes in terms of disability, handicap, and quality of life.

Methods: We studied 87 patients who had a stroke 6 months earlier. Impairments were scored on five stroke scales: the Orgogozo Scale, the National Institutes of Health scale, the Canadian Neurological Scale, the Mathew scale, and the Scandinavian Stroke Scale. Disability was assessed with the Barthel Index, handicap with the Rankin scale, and quality of life with the Sickness Impact Profile. The linear relationship between stroke scales and functional scales was assessed with correlation coefficients. We used regression analyses to explain functional health.

Results: The stroke scales were highly related to one another (range, \( r = -0.85 \) to \( r = 0.92 \)). The correlation between stroke scales and functional scales was \( < 0.70 \) and decreased from Barthel (mean \( r^2 = 47.5\% \)) to Rankin (mean \( r^2 = 36.5\% \)) to Sickness Impact Profile (mean \( r^2 = 33\% \)). Stroke scales were rather poorly correlated with patients' psychosocial conditions (mean \( r^2 = 11.5\% \)). Functional health status was mainly related to leg power and orientation. The standardized stroke scale weights of the explanatory items were lower than their standardized regression weights.

Conclusions: Stroke scales only partly explain functional health. The impact of impairments on functional outcomes seems to be underestimated by the stroke scale weights. The correlation patterns give empirical support to the hierarchical structure of the International Classification of Impairments, Disabilities and Handicaps. (Stroke 1993;24:1178-1181)

KEY WORDS • cerebrovascular disorders • stroke assessment • stroke outcome

In the last decades various stroke scales have been developed. These scales focus on specific manifestations of cerebrovascular disease such as hemiparesis, consciousness, gaze deviation, muscle tone, reflex abnormalities, and intellectual function. The assessment of these impairments in the acute phase of stroke is important both for diagnosis and prognosis.\(^1\)\(^2\)

In the chronic phase of stroke, however, the measurement of neurological impairments is considered to be less important.\(^3\) Although there certainly is a relationship between impairments and long-term functional outcomes, they are not equivalent. For a patient, the most important aspect of his disease is not the grade of hemiparesis as such but his ability to perform daily activities and to fulfill social roles. Nevertheless, some authors claim that a stroke scale can be used as an outcome measure in the (sub)chronic stroke period\(^4\)\(^5\) or argue that stroke scale scores reflect functional health status.\(^6\)

In this study we compared five classic stroke impairment scales with scales measuring disability, handicap, and quality of life. The objectives of our study were (1) to investigate at 6 months after stroke the relationship between neurological impairments and functional health, (2) to assess which elements of the impairment scales are the most important in explaining functional outcome, and (3) to examine the extent to which the impact of the impairments is reflected in the corresponding stroke scale weights.

Subjects and Methods

The study group comprised 87 patients who had a stroke 6 months earlier. They were part of a cohort of 760 consecutive stroke patients who participated in a multicenter study on the quality of care in 26 randomized hospitals in The Netherlands. Mean±SD age of the study group was 71.9±11.52 years, and 53% patients were men. Seventy-four patients had an ischemic stroke, 10 patients had a hemorrhagic stroke, and in 3 patients the nature of the stroke was unknown (computed tomography was not performed).

One of the authors (J.H.) performed a neurological examination of the patients and scored them on five stroke scales: the Orgogozo Scale,\(^7\) the National Insti-
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Table 1. Descriptive Statistics of the Instruments and Correlation Between Five Stroke Scales and the Barthel Index (Disability), Rankin scale (Handicap), and Sickness Impact Profile (Quality of Life)

<table>
<thead>
<tr>
<th>Stroke scale</th>
<th>Score (n=87)</th>
<th>Barthel Index (score, 16.90±4.55)</th>
<th>Rankin scale (score, 2.60±1.25)</th>
<th>Sickness Impact Profile (n=81)</th>
<th>Correlation coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathew scale</td>
<td>77.19±13.72</td>
<td>0.76</td>
<td>−0.71</td>
<td>−0.69</td>
<td>−0.72</td>
</tr>
<tr>
<td>Without functional items</td>
<td>55.79±8.54</td>
<td>0.66</td>
<td>−0.56</td>
<td>−0.52</td>
<td>−0.53</td>
</tr>
<tr>
<td>Orgogozo scale</td>
<td>85.20±18.55</td>
<td>0.70</td>
<td>−0.64</td>
<td>−0.60</td>
<td>−0.68</td>
</tr>
</tbody>
</table>

Scandinavian Stroke Scale

Prognostic score 50.94±10.06 0.83  0.66  0.61  0.69  0.32
Without functional item 40.90±7.50 0.70  0.59  0.55  0.59  0.31
Long-term score 40.98±9.86 0.83  0.66  0.62  0.70  0.33
Without functional items 30.95±7.31 0.70  0.60  0.56  0.60  0.33
National Institutes of Health scale* 3.24±3.96 −0.73  0.60  0.61  0.66  0.38
Canadian Neurological Scale 8.60±1.62 0.64  0.63  0.62  0.68  0.36
Mean $r^2$† 47.5% 36.5% 33% 39% 11.5%

Score values are mean±SD. Correlation values are Pearson’s coefficients.

*Since higher National Institutes of Health scale scores implicate more neurological deficits, signs of the coefficients are opposite those of other scales.

†These values are the mean percentages of the variation of the Barthel Index, Rankin scale, and Sickness Impact Profile “explained” by the stroke scales.

Institutes of Health (NIH) scale, the Canadian Neurological Scale (CNS), the Mathew scale, and the Scandinavian Stroke Scale (SSS). The first three instruments are pure impairment scales. The Mathew scale addresses not only impairments but also a global level of disability. The SSS consists of a prognostic score and a long-term score, with the latter excluding consciousness and eye deviation. Both SSS scoring systems encompass the disability item “gait.”

Disability was assessed with the Barthel Activities of Daily Living (ADL) Index, handicap with the modified Rankin scale, and quality of life with the Sickness Impact Profile (SIP). The SIP is a 136-item functional health questionnaire that focuses on a broad range of physical and psychosocial functions. SIP scores can be aggregated into a total score, a physical and a psychosocial dimension score. The physical dimension mainly refers to (instrumental) disabilities in terms of walking, mobility, body care, and movement. The psychosocial dimension focuses on alertness, emotional behavior, social interaction, and communication.

The linear relationship between the stroke scales scores and scores on the Barthel Index, Rankin scale, and SIP was assessed with Pearson’s product moment correlation coefficients. To evaluate the relationship between individual stroke scale items and the level of disability, handicap, and quality of life, we performed linear regression analyses (with a stepwise backward elimination strategy), using F statistics with $P=.05$ on the criterion level for elimination. The regression coefficients were also used to examine the extent to which the stroke scale weights reflect the impact of the impairments on functional health status. Because the number of items and score ranges of the five stroke scales vary, both the original weights (ie, maximum score of individual items in the stroke scales) and regression weights of the explanatory items were standardized to a 10-point scale.

All analyses were done with sss PC+ 4.0 (SPSS, Inc, Chicago, Ill).

Results

The five stroke scales were related to one another, with correlation coefficients ranging from −.85 to .92.

Table 1 presents the correlation coefficients between the overall stroke scale scores and the scores on the Barthel Index, Rankin scale, and SIP (total and subscales). In general, the correlation coefficients between the stroke scales and the disability, handicap, and quality of life scales did not exceed .70. The correlation decreased from Barthel Index to Rankin scale, and from Rankin scale to SIP total (difference between mean ranks of correlation coefficients, $P<.01$ by Friedman two-way analysis of variance). In comparison with the other stroke scales, the correlation coefficients between both Mathew and SSS and the functional outcomes were higher. However, deleting the functional items of these scales resulted in a drop of the correlation coefficient to values at best similar to the other scales. As is to be expected, the stroke scales were more closely related to the physical subscales than to the psychosocial subscales of the SIP. No differences in correlation coefficients could be found between the SSS scores based on prognostic and long-term scoring systems.

Table 2 presents the results of multiple linear regression analyses in which the levels of disability, handicap, and quality of life were expressed as a linear combination of explanatory stroke scale item scores. In this table the standardized original weights of individual items in the stroke scales (ie, maximum item score) are compared with the standardized weights derived from linear regression analysis. Whereas the original weights are based on a subjective judgment of the relative importance of the items of stroke scales, the weights from the regression analysis provide a relative objective measure for the item’s ability to explain disability, handicap, and quality of life. As can be seen from the standardized...
regression weights, disability, handicap, and quality of life scores were primarily explained by leg power and orientation. At the level of handicap and quality of life, the arm and hand motor functions were also involved. Speech and hemianopia were also related to the patients’ health status. For all three functional outcome measures, the original weights of the most important explanatory items were lower than their corresponding regression weights. In other words, the clinical impact of these impairment items on disability, handicap, and quality of life seems to be underestimated by the original item weights.

**Discussion**

The purpose of this study was to evaluate the relationships between long-term neurological and functional stroke consequences.

The decreasing correlations between stroke scales on the one hand and the Barthel Index, Rankin scale, and SIP on the other are consistent with the hierarchical structure of the World Health Organization’s *International Classification of Impairments, Disabilities and Handicaps* (ICIDH)\(^{15}\) and the way in which quality of life is usually defined.\(^{16}\) A person’s disability is most directly influenced by impairments. Handicap is also determined by the social and societal consequence of impairments and disabilities. Quality of life can be defined as an even broader spectrum of consequences of disease, including elements of disabilities and handicaps, as well as a patient’s perceived health status and well-being. It is therefore not surprising that as health outcomes are measured on a “higher” level of functioning, the correlation with stroke scales decreases.

In the Mathew scale and the SSS, both impairments and aspects of disabilities are summed. When including these nonimpairment items in the analyses, the two scales correlated better in comparison with the other impairment scales. However, in our opinion the addition of unequal measures is conceptually confusing and masks the clinical meaning of the total scale scores.

The SSS is the only scale that uses a separate scoring system to assess long-term stroke outcomes. Since our results did not show higher correlation coefficients for the long-term scoring system compared with its short-term version, one can doubt the surplus value of this distinction.

### Table 2. Linear Regression Models to Explain Disabilities, Handicaps, and Quality of Life by Stroke Scale Items, With Comparison of Standardized Original Weights with Corresponding Standardized Weights Based on Regression Coefficients\(^*\)

<table>
<thead>
<tr>
<th>Stroke scale/Explanatory scale items</th>
<th>Standardized original item weights</th>
<th>Standardized item regression weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathew scale†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leg motor function</td>
<td>0.69</td>
<td>5.96</td>
</tr>
<tr>
<td>Orientation</td>
<td>0.83</td>
<td>4.04</td>
</tr>
<tr>
<td>Arm motor function</td>
<td>0.69</td>
<td>...</td>
</tr>
<tr>
<td>Hemianopia</td>
<td>0.42</td>
<td>...</td>
</tr>
<tr>
<td>Orgogozo scale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leg raising</td>
<td>1.50</td>
<td>3.98</td>
</tr>
<tr>
<td>Leg tone</td>
<td>0.50</td>
<td>6.02</td>
</tr>
<tr>
<td>Hand movements</td>
<td>1.50</td>
<td>...</td>
</tr>
<tr>
<td>Verbal communication</td>
<td>1.00</td>
<td>...</td>
</tr>
<tr>
<td>Scandinavian Stroke Scale‡</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leg motor function</td>
<td>1.67</td>
<td>6.80</td>
</tr>
<tr>
<td>Orientation</td>
<td>1.67</td>
<td>3.20</td>
</tr>
<tr>
<td>Hand motor function</td>
<td>1.67</td>
<td>...</td>
</tr>
<tr>
<td>National Institutes of Health scale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leg motor function</td>
<td>0.97</td>
<td>2.72</td>
</tr>
<tr>
<td>Orientation</td>
<td>0.65</td>
<td>3.31</td>
</tr>
<tr>
<td>Dysarthria</td>
<td>0.65</td>
<td>2.22</td>
</tr>
<tr>
<td>Ataxia</td>
<td>0.65</td>
<td>0.93</td>
</tr>
<tr>
<td>Facial palsy</td>
<td>0.97</td>
<td>0.82</td>
</tr>
<tr>
<td>Arm motor function</td>
<td>0.97</td>
<td>...</td>
</tr>
<tr>
<td>Hemianopia</td>
<td>0.65</td>
<td>...</td>
</tr>
<tr>
<td>Canadian Neurological Scale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leg motor function</td>
<td>1.50</td>
<td>6.61</td>
</tr>
<tr>
<td>Orientation</td>
<td>1.00</td>
<td>3.39</td>
</tr>
</tbody>
</table>

Ellipses indicate that there is no explanatory ability of the item.

\(^*\)Because the number of items and score ranges of the five stroke scales vary, the original weight and regression weights of the explanatory items were standardized to a 10-point scale: standardized original item weight=(maximum score of explanatory item/maximum possible total scale score)×10; standardized item regression weight=([(maximum score of explanatory item×β coefficient)]/2 (maximum score of explanatory item×β coefficient)).

\(^†\)Functional item of the scale was excluded.

\(^‡\)Long-term scoring system, without functional item, was used.
Unlike leg strength, we could not demonstrate a relationship between arm and hand power and disability. An explanation of this phenomenon might be that the Barthel Index emphasizes the mobility aspects of daily living rather than the upper limb function.

In explaining a patient’s level of disability, handicap and quality of life, leg power, and orientation were the most important variables. The clinical meaning of these impairments on the functional outcomes seemed to be underestimated by the corresponding scale weights in the stroke scales. This discrepancy is probably caused by the subjective manner in which scale values have been assigned.

We may conclude that stroke scales measuring at 6 months after stroke only partly explain a patient’s level of disability, handicap, and quality of life. The ability of the stroke scales to explain a patient’s psychosocial condition is rather poor. Second, the demonstrated correlation patterns give empirical support to the hierarchical structure of the ICIDH. Third, the impact of the explanatory impairments, especially leg power and orientation, on a patient’s functional health status is probably underemphasized by the original stroke scale weights. Finally, measures that assess both impairment and functional health status are conceptually confusing and hamper correct clinical interpretations of the total scores; they should be replaced by properly directed instruments.

References
A comparison of five stroke scales with measures of disability, handicap, and quality of life.
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