Evaluation of the American Heart Association Stroke Outcome Classification

Sue-Min Lai, PhD, MS, MBA; Pamela W. Duncan, PhD, PT

Background and Purpose—The purpose of this study was to evaluate the concurrent validity of the American Heart Association Stroke Outcome Classification (AHA.SOC) and compare performance of its function classification with that of the Modified Rankin Scale.

Methods—The individuals in this study included the last 105 consecutive subjects who were part of a cohort of 459 stroke patients in the Kansas City Stroke Study. The patients were evaluated with a variety of standardized assessments at enrollment (within 14 days of stroke onset) and followed at 1, 3, and 6 months after stroke. Specifically, we examined validity of AHA.SOC by comparing its 3 domains (ie, Domain, Severe, and Function) with stroke severity. We correlated AHA.SOC-Function with scores of the Barthel Index, Lawton Instrumental Activities of Daily Living (IADL) Scale, and Medical Outcome Study 36-Item Short-Form Health Survey (SF-36) measures of physical function and mental health. Finally, we compared the discriminant ability of AHA.SOC-Function and the Modified Rankin Scale in assessing disability and handicap. These data were analyzed with the use of Spearman rank correlations and Kruskal-Wallis tests.

Results—All 3 domains of the AHA.SOC were significantly associated with stroke severity and scores of Barthel Index, Lawton IADL, and SF-36 physical function (all \( P < 0.001 \)). Both AHA.SOC-Function and the Modified Rankin Scale discriminated well the disabilities and handicap measured by Barthel Index, Lawton IADL, and SF-36 physical function (all \( P < 0.001 \)).

Conclusions—The AHA.SOC was able to capture impairments, disabilities, and handicap after stroke. The AHA.SOC-Function performed equally as well as the Modified Rankin Scale in assessing disabilities related to basic activities of daily living but differentiated slightly better than the Modified Rankin Scale in assessing disabilities/handicap related to instrumental activities of daily living. Neither the AHA.SOC-Function nor the Modified Rankin Scale captured differences in mental health after stroke. (Stroke. 1999;30:1840-1843.)

Key Words: activities of daily living ■ disability evaluation ■ outcome assessment ■ stroke

A multidisciplinary panel recently created a new stroke outcome classification: the American Heart Association Stroke Outcome Classification\(^1\) (AHA.SOC). The new classification was developed to measure the full range of domains affected by stroke. This new stroke outcome classification has been shown to be a reliable (specifically, interrater reliability) global classification system that summarizes the neurological impairments, disabilities, and handicaps that occur after stroke.\(^1\) The classification schema, which has 3 components, identifies the number of affected neurological domains (AHA.SOC-Domain), identifies the severity of impairments (AHA.SOC-Severity), and classifies poststroke functional disabilities and handicap (AHA.SOC-Function).

The Modified Rankin Scale is the most commonly used outcome classification scale for disabilities and handicap after stroke.\(^2\)\(^-\)\(^7\) The Modified Rankin Scale,\(^2\) which was adopted from the Original Rankin Scale,\(^8\) has 6 grades ranging from grade 0 (no symptoms at all) to grade 5 (severe disability). The Original Rankin Scale was a 5-point rating scale that did not contain grade 0 and defined grade 1 as “no significant disability.” Descriptions for grades 2 to 5 remained the same in both the Original and Modified Rankin scales. Although the Modified Rankin Scale has been evaluated with satisfactory results for its reliability and reproducibility, relatively little is known about its validity.\(^5\)\(^,\)\(^9\)\(^,\)\(^10\) One of the main objections to the Modified Rankin Scale is that it rates disability rather than handicap.\(^10\)\(^-\)\(^12\) Subsequently, the Modified Rankin Scale was further changed by introducing the term *lifestyle* into the definitions for use in the Oxfordshire Community Stroke Study\(^12\) to accommodate language disorder and cognitive defects. The word *disability* in the Modified Rankin Scale was replaced with *handicap* to assess *lifestyle*. Even with this modification, the Oxfordshire Handicap Scale was again shown to be a global functional index rather than a handicap measure. With this in mind, the AHA.SOC was...
developed to expand the classification of stroke outcomes to include handicap.

The purpose of this study was to compare the Modified Rankin classification scale with the newly developed AHA.SOC. Specifically, we examined the classification scales by degree of stroke severity. Second, we correlated outcome classifications with the Barthel Index,13 Lawton Instrumental Activities of Daily Living (IADL),14 and Medical Outcome Study 36-Item Short-Form Health Survey (SF-36).15 measures of physical function and mental health. Finally, we compared the discriminant ability of AHA.SOC-Function and the Modified Rankin Scale in assessing disability and handicap.

Subjects and Methods

The individuals for this study included the last 105 consecutive subjects who were part of a cohort of 459 stroke patients in the Kansas City Stroke Study. The participants were recruited from any of 12 participating hospitals in the greater Kansas City area. Details on subject eligibility and recruitment have been described in a previous report.16 To be accepted into this study, the subject had to have a confirmed eligible stroke, defined by World Health Organization criteria17 as of “rapid onset and of vascular origin reflecting a disturbance of cerebral function, excluding isolated impairments of higher function and persisting longer than 24 hours.” The stroke was confirmed by clinical assessment and/or by a CT/MRI scan. Trained nurses/physical therapists reviewed medical records and interviewed both patients and physicians to determine whether the patient was eligible and had consented to enrollment. The patients were evaluated with a variety of standardized assessments at enrollment (within 14 days of stroke onset) and followed at 1, 3, 6, and 6 months after stroke by a study nurse/physical therapist at home or at a chronic care facility. Therefore, assignment of the AHA.SOC and Rankin classifications was done with knowledge of the results from these standardized assessments. For the present study, assessments that included baseline demographics, stroke characteristics, Orpington Prognostic Scale,18 Barthel Index,13 Lawton IADL,14 SF-36 physical functioning index,15 PFI, and SF-36 mental health index15 (MHI) were analyzed.

AHA.SOC-Domain records the number of affected neurological domains ranging from 0 (0 domains impaired) to 3 (>2 domains impaired). Potential affected neurological domains are motor, sensory, vision, affect, cognition, and language. AHA.SOC-Severity classifies the severity of the identified neurological domains and has 3 levels: A (no/ minimal neurological deficit due to stroke in any domain), B (moderate deficit due to stroke in ≥1 domain(s)), and C (severe deficit due to stroke in ≥1 domain(s)). AHA.SOC-Function classifies functional disabilities and handicap. This component has 5 levels, ranging from level I (independent in basic activities of daily living [BADL] and IADL activities and tasks required of roles patient had before the stroke) to level V (completely dependent in BADL ≥5 areas and IADL). The Modified Rankin Scale has 6 levels, ranging from 0 (no disabilities or symptoms) to 5 (severe disability: bedridden and totally dependent).

The OPS was used to categorize stroke as minor (1.6 ≤OPS ≤3.2), moderate (3.2 ≤OPS ≤5.2), or major (5.2 ≤OPS ≤6.8). The Barthel Index13 measures BADL and is scored on a scale of 0 to 100, with 100 being fully independent in physical functioning. The Lawton IADL14 which ranges from 9 (completely unable to handle instrumental activities) to 27 (without help), was used to assess higher levels of IADL such as grocery shopping and use of telephone. The SF-36 includes 8 domains.15 The present study only analyzed 2 of the 8 SF-36 domains (ie, SF-36 PFI and SF-36 MHI). The SF-36 PFI measures higher level of physical functioning (eg, vigorous and moderate activities, lifting or carrying groceries, and walking >1 mile). The SF-36 MHI assesses mental health dimensions (anxiety, depression, loss of behavioral/emotional control, and psychological well-being). Scores of both the SF-36 PFI and the SF-36 MHI range from 0 to 100, with 100 being fully independent/mentally healthy.

Descriptive statistics were used to show demographics, stroke characteristics, and severity of impairment due to stroke. Since the majority of scales that were used to assess stroke recovery provide ordinal level data that are not normally distributed, all analyses in the present study were performed with the use of nonparametric methods. The concurrent criterion validity of the AHA.SOC was examined by comparing the results from the AHA.SOC with a variety of measures for impairments, disability, and handicap. The impairment part of the AHA.SOC was validated by means of Spearman’s correlation coefficient (r) by correlating scores of AHA.SOC-Domain and AHA.SOC-Severity with stroke severity measured by the OPS. The concordance between scores of the AHA.SOC-Function and the Modified Rankin Scale was expressed in terms of relative frequencies and Somers’ D statistic. Correlations between scores of the AHA.SOC and Modified Rankin Scale and scores of the Barthel Index, Lawton IADL, SF-36 PFI, and SF-36 MHI were calculated with the use of Spearman’s rank correlation coefficient. Kruskal-Wallis tests were used to examine differences in median scores of Barthel Index, Lawton IADL, SF-36 PFI, and SF-36 MHI between patients, with levels of disability and handicap measured by the AHA.SOC and the Modified Rankin Scale.

Results

One hundred five patients were included in this study. The mean age was 71 (±11.2) years at the time of stroke onset. Forty-five subjects (43%) were male. Eighty-three patients (79%) were white, 20 (19%) were black, 1 was Hispanic, and 1 was Asian. Of these 105 patients, ischemic stroke was diagnosed in 99 patients (94%) and intracerebral hemorrhage in 6 patients (6%). The severity of stroke in these 105 patients was minor in 35 patients (33%), moderate in 63 patients (60%), and severe in 7 subjects (7%). By the end of the 6 months, 8 patients died, 10 refused, and 5 moved out of the study area.

Table 1 shows the relationship between stroke severity characterized by the OPS and baseline impairment, disability, and handicap measured by AHA.SOC and the Modified Rankin Scale. All 7 patients (100%) who had severe stroke had >2 domains with neurological impairment, while 44 of the 63 patients (70%) with moderate stroke and 13 of the 35 patients (37%) with minor stroke had >2 domains with neurological impairment (Table 1). The association was found to be statistically significant between the number of neurological domains impaired and stroke severity (r = 0.36; P < 0.001). Similarly, all 7 patients with severe stroke had severe neurological impairment in ≥1 domain(s), whereas 37 of the 63 moderate strokes (59%) and 3 of the 35 minor strokes (9%) had severe neurological impairment in ≥1 domain(s) (Table 1). The correlation coefficient was 0.55, which was statistically significant (P < 0.001). AHA.SOC classification of disability/handicap was also significantly associated with stroke severity (r = 0.67; P < 0.001). Modified Rankin classifications also differed across minor, moderate, and major strokes (r = 0.65; P < 0.001).

The Spearman correlation between the baseline AHA.SOC-Function and the baseline Modified Rankin Scale was found to be 0.70 (P < 0.001). Since none of the 105 patients had a Rankin score of 0 (ie, no symptoms) at baseline, scores of the AHA.SOC-Function and the Modified Rankin Scale were further analyzed with the use of Somers’ D statistic (Table 2). The Somers’ D statistic of 0.65 (P = 0.035) confirmed the mutual agreement of these 2 measures of disabilities and handicap.
TABLE 1. Baseline Characteristics of the Study Participants (n=105)

<table>
<thead>
<tr>
<th>AHA.SOC-Domain</th>
<th>Total (n=105)</th>
<th>Minor Stroke (n=35)</th>
<th>Moderate Stroke (n=63)</th>
<th>Severe Stroke (n=7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHA.SOC-Severity</td>
<td>0 1 2 3</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>AHA.SOC-Function</td>
<td>I 1 2 3 4 5</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Modified Rankin Scale</td>
<td>0 1 2 3 4 5</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

TABLE 2. Agreement for Degree of Disability/Handicap Assessed at Enrollment Using the AHA.SOC-Function Subscale and the Modified Rankin Scale

<table>
<thead>
<tr>
<th>AHA.SOC-Function</th>
<th>Modified Rankin Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5</td>
<td>...</td>
</tr>
</tbody>
</table>

TABLE 3. Median Scores of Barthel Index, Lawton IADL, SF-36 PFI, and SF-36 MHI Measured at 1 Month After Stroke in Relation to AHA.SOC and Modified Rankin Scale

<table>
<thead>
<tr>
<th>AHA.SOC-Function</th>
<th>Lawton IADL</th>
<th>SF-36 PFI</th>
<th>SF-36 MHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>I 2 3 4 5</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Modified Rankin Scale

<table>
<thead>
<tr>
<th>Modified Rankin Scale</th>
<th>Lawton IADL</th>
<th>SF-36 PFI</th>
<th>SF-36 MHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5</td>
<td>...</td>
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<td>...</td>
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</table>

There were no cases in the Modified Rankin Scale of 0.

Median 1-month scores of the Barthel Index, Lawton IADL, SF-36 PFI, and SF-36 MHI are shown in Table 3. The correlations between the AHA.SOC-Function classification and 1-month scores of the Barthel Index, Lawton IADL, SF-36 PFI, and SF-36 MHI were $-0.87 (P<0.001)$, $-0.85 (P<0.001)$, $-0.70 (P<0.001)$, and $-0.12 (P=0.25)$, respectively. Similarly, the correlations between the Modified Rankin Scale and 1-month scores of the Barthel Index, Lawton IADL, SF-36 PFI, and SF-36 MHI were $-0.89 (P<0.001)$, $-0.81 (P<0.001)$, $-0.70 (P<0.001)$, and $-0.09 (P=0.41)$, respectively.

Table 4 summarizes $\chi^2$ values associated with testing the differences in median 1-month, 3-month, and 6-month scores on the Barthel Index, Lawton IADL, SF-36 PFI, and SF-36 MHI across the levels of AHA.SOC-Function and the Modified Rankin Scale. Median Barthel scores were significantly different between the 5 levels of AHA.SOC-Function ($\chi^2=74; P<0.001$) and the 5 levels of Modified Rankin Scale ($\chi^2=80; P<0.001$). For Lawton IADL, a Kruskal-Wallis ANOVA also showed highly significant differences in median scores between the levels of AHA.SOC-Function ($\chi^2=71; P<0.001$) and the levels of Modified Rankin Scale ($\chi^2=64; P<0.001$). For SF-36 PFI, significant differences in median score were also observed ($\chi^2=45, P<0.001$ for AHA.SOC-Function; $\chi^2=44, P<0.001$ for Modified Rankin Scale). No differences in median score of SF-36 MHI were found in either AHA.SOC-Function or the Modified Rankin Scale. Similar results were observed when scores of 3-month
Discussion
The AHA.SOC was designed as a classification system to comprehensively document stroke impairments and disabilities in a single summary stroke score. Its validity of documenting impairment domains and severity was tested in terms of correlation with stroke severity and level of disability after stroke. The strong association of AHA.SOC with stroke severity measured with the OPS and Barthel Index indicates concurrent validity of impairment assessment (Table 1).

The AHA.SOC-Function and the Modified Rankin Scale are similar and strongly correlated (Somers’ D = 0.65; P < 0.001). Both classifications differentiated stroke severity, disabilities in BADL and IADL, and physical function (Table 4). Neither of them differentiated mental health status (Table 4). The AHA.SOC-Function only differs from the Modified Rankin Scale in that full range of the AHA.SOC-Function is more likely to be used to demonstrate patients’ level of outcome after stroke (Table 2). Patients are more likely to be assigned a grade 5 at baseline (within 14 days of stroke onset), indicating the worst outcome, when AHA.SOC-Function is used. The assignment of outcome classification is more likely to be distributed across all levels of the AHA.SOC-Function than the Modified Rankin Scale. Fifty-three percent of the patients were assigned grade 4 baseline by the Modified Rankin Scale, while the same group of individuals were primarily distributed across 2 functional levels (from 4 to 5) by AHA.SOC-Function (Table 2).

Our study results are consistent with those reported by de Hann et al., although in their study the Oxford Handicap Scale (which was modified from the Modified Rankin Scale by replacing disability with handicap) was used. de Hann et al. also noted in their study that IADL was associated with the Oxford Handicap Scale, although the magnitude of association was weaker than with BADL. Our study results also supported their findings in the relationship between the Modified Rankin Scale and disability in IADL (χ² = 80 for Barthel Index and χ² = 64 for IADL; Table 4). However, we observed that the ability of AHA.SOC-Function to discriminate disability in IADL did not decline (χ² = 74 for Barthel Index and χ² = 71 for IADL; Table 4).

In our study, both the AHA.SOC and the Modified Rankin Scale were scored after a battery of instrument assessments. Consistency in scoring of these 2 measures after a battery of instrument assessment made comparison of these 2 instruments possible. AHA.SOC is a valid stroke outcome classification schema. All 3 domains of the AHA.SOC were able to capture impairments, disabilities, and handicap after stroke. The assignment of outcome classification is more likely to be distributed across all levels of the AHA.SOC-Function than the Modified Rankin Scale. The AHA.SOC-Function subscale performs equally as well as the Modified Rankin Scale in assessing disabilities related to BADL. Neither AHA.SOC-Function nor the Modified Rankin Scale captured differences in mental health after stroke. In everyday clinical practice, where a limited number of assessments are done, it may be less likely to obtain a summary score with the use of the AHA.SOC, whereas the Modified Rankin Scale can be easily obtained. The AHA.SOC, however, can provide a more comprehensive clinical assessment of impairment, severity, and handicap when data are available. Finally, very few severe stroke patients (n = 7) and patients with very mild stroke (Rankin 0 to 2; n = 8) were included in this study, and therefore the validity of the AHA.SOC classification system applied to these patients remains to be tested.

Acknowledgments
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References
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