Validation of a Prognostic Subarachnoid Hemorrhage Grading Scale Derived Directly From the Glasgow Coma Scale

Annemarie W. van Heuven, MD; Sanne M. Dorhout Mees, MD; Ale Algra, MD; Gabriel J.E. Rinkel, MD

Background and Purpose—A new Glasgow Coma Scale-based scale has been developed to predict patient outcome in subarachnoid hemorrhage by calculating cut-off points by which 2 consecutive categories corresponded to a statistically significant different outcome. We assessed the external validity of this Prognosis on Admission of Aneurysmal Subarachnoid Hemorrhage (PAASH) scale and compared it to the commonly used World Federation of Neurological Surgeons scale.

Methods—From our database of subarachnoid hemorrhage patients we retrieved data on all patients admitted between November 2000 and March 2006. By means of logistic regression, we calculated OR with corresponding 95% CI for poor outcome at 3 months for each category in comparison with the lowest category of both scales. Areas under the curve of the corresponding receiver operator characteristic curve were calculated.

Results—We included 537 patients. For the PAASH scale, OR ranged from 3.9 (95% CI, 2.4 to 6.2) to 84 (95% CI, 25 to 287) and increased more evenly than for the World Federation of Neurological Surgeons (WFNS) scale, with OR ranging from 2.3 (95% CI, 1.3 to 4.1) to 69 (95% CI, 31 to 157). Areas under the curve were 0.81 (95% CI, 0.77 to 0.84) for the PAASH and 0.82 (95% CI, 0.79 to 0.86) for the WFNS scale.

Conclusion—Both PAASH and WFNS scales have a good discriminatory ability for patient prognosis. Because the OR of the PAASH increase more gradually, it is slightly preferable to the WFNS scale. (Stroke. 2008;39:1347-1348.)

Key Words: outcome ■ prognosis ■ subarachnoid hemorrhage

T

he World Federation of Neurological Surgeons (WFNS) Committee scale is a commonly used scale to determine the prognosis after subarachnoid hemorrhage (SAH).1 This scale is based on the Glasgow Coma Scale (GCS), with focal deficits making up 1 additional level for patients with a GCS score of 14 or 13. The cut-off points in the WFNS scale are based on consensus, not on formal analysis. To date, the scale has not been thoroughly validated.

Another 5-category grading scale, the Prognosis on Admission of Aneurysmal Subarachnoid Hemorrhage (PAASH) grading scale, has been developed based solely on the GCS.2 The cut-off points between the categories were selected by calculating at which point 2 consecutive categories corresponded to a statistically significant different outcome at 6 months. However, the external validity of this scale has not been assessed. In our study population, we determined the relation between the categories on the PAASH and WFNS scales and actual outcome, and compared the prognostic accuracy of both scales.

Materials and Methods

Patients

Patients were retrieved from a prospectively collected database of all patients with SAH admitted to the University Medical Center Utrecht, when they presented with aneurysmal SAH between November 2000 and March 2006 within 4 days after the hemorrhage. The diagnosis of aneurysmal SAH was based on the presence of blood on CT (or in case CT was negative on presence of xanthochromia in cerebral spinal fluid) in combination with an aneurysm confirmed on CT or conventional angiography. Exclusion criteria were: (1) GCS on admission irretrievable; (2) outcome at 3 months unknown; and (3) age younger than 16 years. Data were retrieved on age, GCS, and WFNS score on admission, and amount of extravasated blood on initial CT scan with the Hijdra score.3

Based on their GCS on admission, patients were divided into the 5 categories of the PAASH: (1) GCS 15; (2) GCS 11 to 14; (3) GCS 8 to 10; (4) GCS 4 to 7; and (5) GCS 3. In case of aphasia, patients were classified according to clinically possible GCS scores, derived from their eye and motor scores. When different possible verbal scores would place patients in different categories, these patients were excluded.

Outcome was measured with either the Glasgow Outcome Scale or the modified Rankin scale.4,5 Two different outcome scales were used, because several patients were enrolled in a clinical trial that used the modified Rankin scale, whereas our center usually measures outcome with the Glasgow Outcome Scale. Poor outcome was defined as Glasgow Outcome Scale 1 to 3 or Rankin 4 to 5, or death. If Glasgow Outcome Scale and Rankin gave different dichotomy outcomes, patients were categorized according to the Glasgow Outcome Scale.

Data Analysis

OR for poor outcome with 95% CI were calculated for each category of the PAASH and the WFNS scale with logistic regression with the lowest category taken as reference. Receiver operator characteristic curves were plotted and the areas under the curve were calculated to...
determine the discriminatory ability of both scales. Age and the Hijdra score, dichotomized on the median, were added to the logistic regression model.

Results
In total 632 patients were admitted within 4 days during the study period. For 76 patients outcome was known only at discharge and not at 3 months. For 10 patients the GCS on admission was not documented. Nine patients could not be categorized because of dysphasia or intubation.

Baseline characteristics for the 537 included patients are shown in Table 1. For the PAASH scale, OR for poor outcome increased more evenly than for the WFNS scale (Table 2). The areas under the curve of the receiver operator characteristic curves were similar for the PAASH (0.81; 95% CI, 0.77 to 0.84) and the WFNS scale (0.82; 95% CI, 0.78 to 0.86). The areas under the curve did not change substantially when the Hijdra score or age were added to the logistic regression model.

Discussion
Our study shows that both the PAASH and WFNS scale have a good discriminatory ability with regard to patient prognosis. However, OR increased more gradually in the PAASH scale and areas under the curve were similar for both scales.

Predicting outcome of aneurysmal SAH remains a problematic issue. The clinical condition can vary during the acute phase, and complications occurring during the clinical course can influence outcome. Thus, a scale applied on admission will never give a 100% perfect prediction of outcome. Nevertheless, grading patients with SAH on admission is important for clinical and research purposes. The PAASH scale has a good internal and external validity regarding to clinical outcome. Moreover, in our study population, <2% could not be classified because of early intubation, which means that the PAASH scale can be applied in almost all patients with SAH.

To date, there is no universally accepted scale to assess the clinical condition on admission. Both the Hunt and Hess scale and the WFNS scale are widely used in clinical practice and in research reports. Because the interobserver agreement for the Hunt and Hess scale is poor, clinicians using this scale should be advised to use another scale. For these clinicians switching to the PAASH grading scale seems the best choice. Of course it would be better if one scale is used worldwide. Because the PAASH scale is very easy to apply, and based solely on the GCS, which has a much better interobserver agreement, we propose using this scale instead of the other scales in use today.

In conclusion, both the WFNS and PAASH scales have a good prognostic value for patient outcome. However, the PAASH scale shows a more gradual increase of OR in ascending categories. Based on the results of our study, we think the PAASH scale is slightly preferable over the WFNS scale.

Disclosures
None.

References
Validation of a Prognostic Subarachnoid Hemorrhage Grading Scale Derived Directly From the Glasgow Coma Scale
Annemarie W. van Heuven, Sanne M. Dorhout Mees, Ale Algra and Gabriel J.E. Rinkel

*Stroke*. 2008;39:1347-1348; originally published online February 28, 2008;
doi: 10.1161/STROKEAHA.107.498345
*Stroke* is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2008 American Heart Association, Inc. All rights reserved.
Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/39/4/1347

**Permissions:** Requests for permissions to reproduce figures, tables, or portions of articles originally published in *Stroke* can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

**Reprints:** Information about reprints can be found online at:
http://www.lww.com/reprints

**Subscriptions:** Information about subscribing to *Stroke* is online at:
http://stroke.ahajournals.org//subscriptions/