A Novel, Easy-to-use Grading System for Predicting Mortality and Functional Outcome on Discharge in Patients with Subarachnoid Hemorrhage

Georgios Maragkos; Alejandro Enriquez-Marulanda; Mohamed Salem; Luis Ascanio; Kohei Chida; Raghav Gupta; Abdulrahman Alturki; Kimberly Kicielinski; Christopher Ogilvy; Justin Moore; Ajith Thomas

Division of Neurosurgery, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA, USA

Beth Israel Deaconess Medical Center
HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

Introduction

Multiple grading systems have been proposed to predict outcomes for patients presenting with aneurysmal subarachnoid hemorrhage (aSAH), however, they may be difficult to use. The aim of our study is to provide a readily-usable, three-point prediction score, to gauge aSAH patient outcomes in the emergency setting.

Methods

A retrospective cohort comparison study design was implemented, which included all patients with aSAH presenting to a single US academic institution between 2007-2016. Patients with favorable outcome, defined as modified Rankin Scale scores 0-1 on discharge, were compared against those with unfavorable outcome (scores 2-6). Variables that were significant in univariate analysis were then utilized to run a multivariate logistic regression and build a predictive model. The ROC curve was used to evaluate the discriminative performance of the model and compare performance to established grading systems.

Table 1. The proposed 3-variable aSAH Scoring System

Variable	Points
GCS 3-8	2
Age ≥ 60 years	1
SAH thickness ≥ 7 mm	1
Total	**0-4**

Results

279 patients were included in the analysis; 152 patients (54.5%) had favorable and 127 (45.5%) had unfavorable outcomes. Based on multivariate analysis, the following parameters were selected: 2 points for Glasgow Coma Scale of 3-8, 1 point for age >60 years and 1 point for SAH thickness >7 mm, with a total score ranging from 0-4. Our model demonstrated an area under the curve of 82.2% for detecting unfavorable outcome, which was similar to Hunt and Hess (80.3%, p=0.467) and modified MGH (78.8%, p=0.089) and significantly better than WFNS (77.6%, p=0.034), and MGH (75.61%, p=0.009). A score of 2-4 had an OR 12.92 (95% CI 7.21-23.14; p<0.001), sensitivity 83.33% and specificity 76.47% for predicting discharge mRS 2-6.

Table 2. Logistic regression predicting bad outcome

Variables	OR (CI 95%)	p-Value
Age ≥60 years	2.33 (1.17 to 4.64)	**0.016**
GCS 3-8	4.18 (1.74 to 10.06)	**0.001**
Hunt & Hess 4-5	2.70 (1.04 to 7.01)	**0.041**
Modified Fisher	0.76 (0.47 to 1.20)	0.24
Intraparenchymal Hemorrhage	1.66 (0.72 to 3.83)	0.23
Hydrocephalus on initial CT	1.61 (0.83 to 3.15)	0.16
Antiplatelet medications on admission	2.55 (1.03 to 6.31)	**0.043**
SAH thickness≥7mm	2.51 (1.25 to 5.04)	**0.01**

Figure 1a. ROC curve comparison
A. 3-point SAH score vs Hunt & Hess
3-point SAH score AUC: 0.82 — Hunt & Hess AUC: 0.8029 — Reference
E. 3-point SAH score vs MGH scale
3-point score AUC: 0.82 — MGH AUC: 0.7552 — Reference

Figure 1b. ROC curve comparison
B. 3-point SAH score vs WFNS
3-point score AUC: 0.82 — WFNS AUC: 0.7728 — Reference
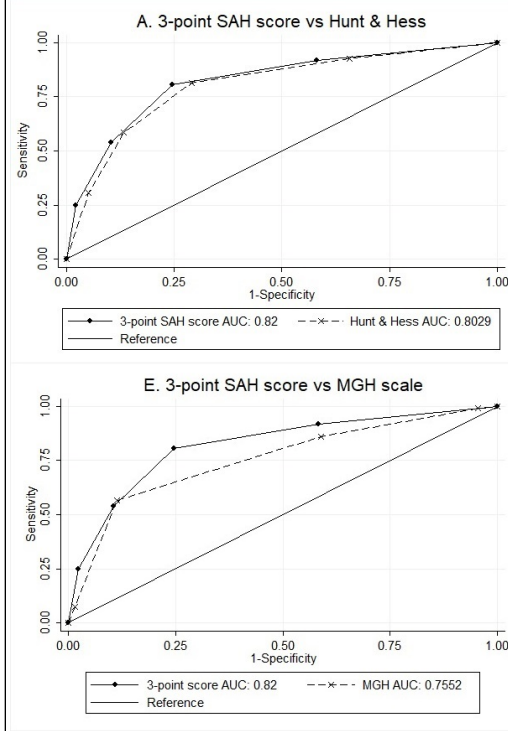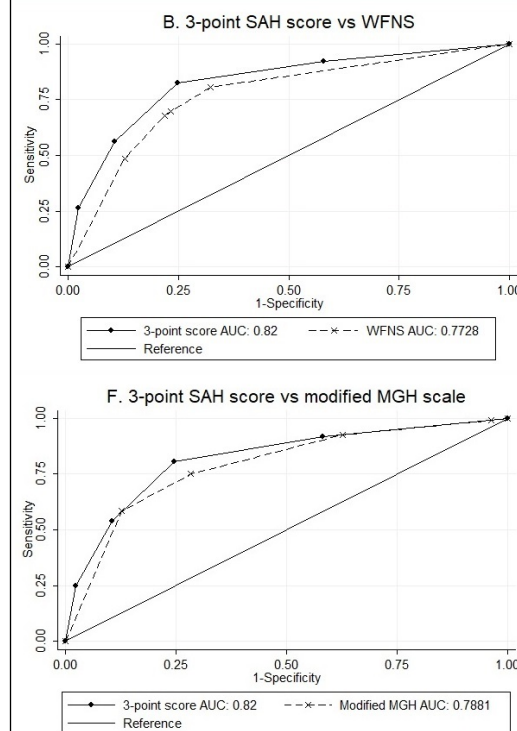F. 3-point SAH score vs modified MGH scale
3-point score AUC: 0.82 — Modified MGH AUC: 0.7881 — Reference

Conclusions

We propose a three-variable grading system to predict discharge mortality and functional outcome in patients arriving at the emergency department with aSAH. Our scale is easy to apply, particularly for junior staff and can help guide acute therapeutic planning and manage outcome expectations.

References

1. Ogilvy CS, Carter BS. A proposed comprehensive grading system to predict outcome for surgical management of intracranial aneurysms. Neurosurgery. 1998;42(5):959-968; discussion 968-970.
2. Lagares A, Gomez PA, Alen JF, et al. A comparison of different grading scales for predicting outcome after subarachnoid haemorrhage. Acta Neurochir (Wien). 2005;147(1):5-16.
3. Dengler NF, Diesing D, Sarrafzadeh A, Wolf S, Vajkoczy P. The Barrow Neurological Institute Scale Revisited: Predictive Capabilities for Cerebral Infarction and Clinical Outcome in Patients With Aneurysmal Subarachnoid Hemorrhage. Neurosurgery. 2017;81(2):341-349.
4. Weisscher N, Vermeulen M, Roos YB, de Haan RJ. What should be defined as good outcome in stroke trials; a modified Rankin score of 0-1 or 0-2? J Neurol. 2008;255(6):867-874.