The Principle of Parsimony: Glasgow Coma Scale Score Predicts Mortality as Well as the APACHE II Score for Stroke Patients

Scott Weingarten, MD, MPH, Roger Bolus, PhD, Mary S. Riedinger, RN, BSN, Lawrence Maldonado, MD, Steven Stein, and A. Gray Ellrodt, MD

Although the development and use of severity-of-illness measures has gained widespread enthusiasm, uncertainty remains as to the optimal measure for stroke patients. The Health Care Financing Administration recently derived a severity-of-illness measure based on the APACHE II system to explain differences in Medicare mortality rates among hospitals treating stroke patients. We hypothesized that the Glasgow Coma Scale score provides prognostic information of accuracy comparable to that of the APACHE II score for stroke patients, yet is simpler and cheaper to abstract from the medical record. We therefore studied 246 patients hospitalized with stroke, including 49 oversampled mortalities. The Glasgow Coma Scale score was as accurate as the APACHE II score in predicting stroke mortality both before (r=-0.50 and r=0.50, respectively) and after (r=-0.40 and r=0.38, respectively) the oversampled mortalities were excluded. The APACHE II score required abstraction of 16 variables from the medical record compared with three for the Glasgow Coma Scale score and required more than three times the time to abstract from the medical record. Therefore, in the interest of parsimonious data collection, the Glasgow Coma Scale may be a preferable severity-of-illness measure for patients with stroke. (Stroke 1990;21:1280–1282)

Measurement of severity of illness has become a vital component of health care research over the past decade1–3 for its potential value in assessing quality of care. For real-time use, accurate prognostic assessment may assist clinical management and counseling of patients and their families.1 In addition, severity indicators are useful for selecting and comparing patients in clinical trials. Retrospective assessment of illness severity is invaluable for making inferences about quality of care and is required to facilitate comparisons of hospitals’ expected mortality rates with their actual mortality rates.2,3

Although stroke is the third leading cause of death in the United States and is responsible for 5% of all acute-care bed-days,4 few severity-of-illness measures assess prognosis in such patients. Moreover, the Health Care Financing Administration (HCFA) has targeted stroke for development of a severity indicator to assist in case-mix adjustment of Medicare mortality data.2,3 In a recent study performed by HCFA and the Health Data Institute,2 a severity-of-illness measure based on the APACHE II system,5 a measure validated in intensive care unit patients, was derived for stroke patients. This measure may be used to facilitate analysis of Medicare mortality rates at hospitals throughout the country.2 However, the Glasgow Coma Scale,6 because of its relative simplicity of measurement and abstraction, may be preferable to the APACHE II system as a severity-of-illness measure if the former demonstrates comparable accuracy. We therefore directly compared the accuracy of the APACHE II system with that of the Glasgow Coma Scale for patients hospitalized with stroke.

Subjects and Methods

The study was performed at Cedars–Sinai Medical Center, an 1,100-bed community teaching hospital serving west Los Angeles. Medical records of patients discharged with the principal diagnosis of stroke between July 2, 1986, and June 26, 1987, were abstracted. Medical records were recovered for 197 patients (91% recovery rate). We oversampled 49
additional patient deaths, bringing the total patient cohort to 246. Survival was assessed at the time of hospital discharge. Patients >18 years of age hospitalized with a sudden neurologic deficit consistent with cerebral infarction, ischemia, hemorrhage, embolism, or thrombosis were included in the study. We excluded patients with a neurologic deficit due to cerebral aneurysm or arteriovenous malformation without stroke, neoplasm, trauma, or subdural or epidural hematomata and patients whose symptoms resolved ≤24 hours after admission.

A trained chart abstractor audited the medical records using precoded forms. The first complete set of data available was used to compute the APACHE II score and the Glasgow Coma Scale score; all data were obtained ≤24 hours after admission. Normal values were substituted for missing values. The Glasgow Coma Scale is a 15-point measure of neurologic dysfunction, with lower scores denoting more severe impairment. The APACHE II system incorporates physiologic variables, age, and a chronic health evaluation into a measure of the risk of mortality; the higher the score the worse the prognosis.

Interrater agreement was measured in a 10% random sample of the original patient cohort (excluding oversampled mortalities). Differences between raters of ≤1 point for both the APACHE II score and the Glasgow Coma Scale score were accepted as agreement. In addition, a reviewer recorded the time required for abstraction of data for each score from the medical records of 20 patients.

Student’s t test was used to compare continuous data. Correlational analysis was performed using SAS.7 A probability value of <0.05 was considered to indicate statistical significance.

Results

Of the 246 patients enrolled in the study, 96 (39%) were male, and 221 (90%) were white. The mean age was 77 years. At admission, 83% of the patients resided in their home, 8% in a nursing home, and 9% in a board-and-care facility. A total of 76% (188) of the patients were admitted to the medical ward, 20% (50) to the intensive care unit, and 3% (8) to the intermediate care unit. Discharge diagnosis was cerebral infarction in 70% (172), lacunar infarction in 9% (22), intracerebral hemorrhage in 7% (17), cerebellar infarction in 6% (15), brain stem infarction in 4% (10), and cerebellar or subarachnoid hemorrhage in 4% (10). Twenty-two patients (9%) died during hospitalization, excluding the oversampled mortalities.

The Glasgow Coma Scale score was 15 in 54%, 10–14 in 26%, and <10 in 20% of the patients. The APACHE II score was 0–5 in 7% (17), 6–10 in 47% (115), 11–16 in 26% (64), 17–20 in 11% (26), and >20 in 10% (24).

The average Glasgow Coma Scale score for survivors was 13.7 compared with 9.9 for nonsurvivors (p<0.0001). The mean APACHE II score for survivors was 9.8 compared with 16.2 for nonsurvivors (p<0.0001). The Glasgow Coma Scale score correlated with mortality (r=-0.50, p<0.001) as well as did the APACHE II score (r=0.50, p<0.0001). When the oversampled mortalities were excluded, the Glasgow Coma Scale still performed as well as the APACHE II system (r=-0.40 and r=0.38, respectively).

The mean±SEM time required to abstract the Glasgow Coma Scale score was 1.1±0.6 minutes; that for the APACHE II score was 3.7±1.0 minutes (p<0.000001). Therefore, abstraction and scoring of the Glasgow Coma Scale took less than one third the time of the APACHE II system. The interrater agreement for the Glasgow Coma Scale score was 90% compared with 70% for the APACHE II score.

Discussion

Both the Glasgow Coma Scale and the APACHE II system are desirable severity-of-illness measures since they are objective, reliable, and suitable for retrospective or prospective review. Since both severity measures are assessed upon hospital admission, they are treatment-independent and therefore are insensitive to differences in quality of care. In our study, the Glasgow Coma Scale score predicted mortality as well as the APACHE II score for stroke patients. The APACHE II score consists of the Glasgow Coma Scale score plus 11 other physiologic variables, age, and a chronic health evaluation.5

Abstraction and scoring of the APACHE II system took approximately three times as long as abstraction and scoring of the Glasgow Coma Scale. Thus, use of the Glasgow Coma Scale may be advantageous since data collection is less labor-intensive and cheaper than for the APACHE II system.

The optimal severity-of-illness measure for stroke patients has not yet been determined. Previously used measures include the APACHE II system,5,8 a model based on the APACHE II system,2,3,5,10 and the presence or absence of a mass effect on a computed tomogram.9 The APACHE II system is a widely accepted mortality predictor for intensive care unit patients, but its accuracy for patients hospitalized outside the unit is unknown.5 In addition, more elaborate prognostic predictors for stroke are being developed, but these measures may be limited by the lack of universal availability of information derived from retrospective chart abstraction.11 The Medicare Mortality Prediction System (MMPS), a fairly detailed severity-of-illness measure based on the APACHE II system, may provide a more accurate assessment for stroke patients. The disadvantage of the MMPS is that it requires far greater resources to abstract the information required than either the APACHE II system or the Glasgow Coma Scale.2

We used in-hospital mortality rather than the 30-day mortality rate to define survival, which is consistent with the outcome used in previous validation studies of the APACHE II system and the Glasgow Coma Scale. In a pragmatic sense, the effort and cost for hospitals to compute 30-day mortality...
rates may be prohibitive. However, the MMPS has adopted the 30-day mortality rate to define survival to control for differences in discharge procedures (e.g., hospice transfers) in contributing to mortality rates. The predictive abilities of the APACHE II system and the Glasgow Coma Scale for 30-day mortality rates have yet to be defined.

The Glasgow Coma Scale and the APACHE II system probably predict neurologic dysfunction poorly in patients with focal brain disease. The APACHE II score and the Glasgow Coma Scale score are derived solely from physiologic variables, which correlate well with survival but perhaps less well with functional status. Since the only outcome measured in our study was survival, the severity-of-illness measures that we employed appear to have been appropriate.

The accuracy of the Glasgow Coma Scale has been well established for patients with head trauma\(^6\) and more recently for patients suffering out-of-hospital cardiac arrest.\(^12\) The Glasgow Coma Scale has fared well in predicting outcome for patients with intracerebral hemorrhage,\(^13,14\) although its accuracy in predicting outcome for patients with nonhemorrhagic stroke is uncertain. We suggest that the Glasgow Coma Scale is a useful severity-of-illness measure for stroke patients, including those without intracerebral hemorrhage (93% of our study patients) and may be used instead of the APACHE II system for that purpose. In fact, the APACHE II score added no additional predictive information to that provided by the Glasgow Coma Scale score, although the former required much more time to abstract. Further research is required to determine whether the Glasgow Coma Scale may be employed to measure the effectiveness of medical care.

**References**


**KEY WORDS** • cerebrovascular disorders • mortality • prognosis
The principle of parsimony: Glasgow Coma Scale score predicts mortality as well as the APACHE II score for stroke patients.
S Weingarten, R Bolus, M S Riedinger, L Maldonado, S Stein and A G Ellrodt

*Stroke*. 1990;21:1280-1282
doi: 10.1161/01.STR.21.9.1280

*Stroke* is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 1990 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/21/9/1280

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/