A model for predicting the growth of unruptured intracranial aneurysms
Beyond fortune telling

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Because of the tremendous initial and long-term morbidity and mortality incurred by intracranial aneurysm rupture, preventive treatment of unruptured intracranial aneurysms is an appealing strategy to prevent subarachnoid hemorrhage (SAH). However, intervention with surgical or endovascular therapy has risk for considerable procedural complications, especially for large or posterior circulation aneurysms. Therefore, determining the indications for treatment is crucial to optimizing the management of unruptured aneurysms. Approximately 10% to 20% of unruptured aneurysms will enlarge over the first 10 years of follow-up, and this proportion increases to nearly 50% at 20 years. Growing unruptured aneurysms pose substantially greater risk of rupture compared to those of stable size; one study found that growing unruptured aneurysms had a 12-fold higher rupture risk. On the basis of these findings, unruptured aneurysm growth has served as a surrogate indicator of impending rupture and thus as an impetus for intervention.

In this issue of Neurology®, Backes et al. developed the ELAPSS score (earlier subarachnoid hemorrhage, location of the aneurysm, age >60 years, population, size of the aneurysm, and shape of the aneurysm) to predict the growth of unruptured aneurysms using a weighted composite of patient- and aneurysm-specific characteristics. The authors derived this novel scoring system from their analysis of pooled data from 10 centers in 5 countries, including 1,507 patients with 1,909 unruptured aneurysms (median follow-up duration 2.5 years). Aneurysm growth occurred in 17% of patients and 14% of unruptured aneurysms at a median time interval of 1.9 years. The factors comprising the ELAPSS acronym are earlier SAH (no prior SAH = 1 point), location of aneurysm (middle cerebral artery = 3 points, posterior communicating artery and posterior circulation = 5 points), age (>60 years = 1 point), population (Japan = 1 point, Finland = 7 points), size of aneurysm (3.0–4.9 mm = 4 points, 5.0–6.9 mm = 10 points, 7.0–9.9 mm = 13 points, >10.0 mm = 22 points), and shape of aneurysm (irregular = 4 points). The 5-year risk of aneurysm growth ranged from 8.4% to 60.8% for ELAPSS scores <5 and ≥25, respectively. The median and most frequent ELAPSS score bracket was 5 to 9, which corresponded to a 5-year aneurysm growth risk of 13%.

The challenge of scoring systems in medicine lies in striking a balance between simplicity and accuracy; an overly simple scoring system may lack sufficient predictive capability, whereas one that is too complex may fail to attain widespread adoption. While the ELAPSS score provides a quantitative risk for aneurysm growth, its practicality in the clinical setting remains unknown. The PHASES score (population, hypertension, age, size of aneurysm, earlier subarachnoid hemorrhage from another aneurysm, site of aneurysm) was recently developed as a tool for predicting the rupture risk of unruptured aneurysms, and many of the factors making up the PHASES score overlap with those constituting the ELAPSS score. Although the PHASES score also predicted aneurysm growth in a subsequent analysis, the present study suggests that it underestimates growth compared to the ELAPSS score.

On the basis of the current analysis, the ELAPSS score could complement the PHASES score to guide the follow-up of patients with unruptured aneurysm. However, the ELAPSS score has several limitations, underscored by contrasting its contributing factors to those of the PHASES score. First, prior SAH and anterior communicating artery aneurysm location were positive predictors of rupture in the PHASES score but negative predictors of growth in the ELAPSS score. This suggests that patients with a history of SAH and anterior communicating artery aneurysms were selectively targeted for treatment and therefore less likely to be followed up with serial imaging. Second, hypertension was a component of the PHASES score but not the ELAPSS score. Third, both the PHASES and ELAPSS scores could not account for current or prior smoking status. Smoking has both a dose-dependent and cumulative association with the risk of aneurysm rupture and appears to affect women more than men. Therefore, it is important to consider that neither smoking nor hypertension, the only 2 modifiable risk factors, was

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incorporated into the ELAPSS score. Lastly, it is important to note that a certain proportion of unruptured aneurysms could be structurally unstable on a molecular (e.g., degradation of the extracellular matrix) or cellular (e.g., aneurysm wall inflammation) level, without any evidence of macroscopic growth. These limitations emphasize that aneurysm scoring models such as PHASES, the unruptured intracranial aneurysm treatment score, and now ELAPSS never apply to the entire population of unruptured aneurysms; that is, they serve only as a basis for more robust management and counseling of these patients but are never definitive.

The ELAPSS score may prove to be a useful multifactorial decision-making tool for determining the follow-up of unruptured aneurysms, but the management strategy for these lesions must be supplemented by numerous patient- and aneurysm-specific characteristics not accounted for in the scoring system. Compared to ruptured aneurysms, the treatment of unruptured aneurysms incurs less procedural morbidity and requires a substantially shorter hospitalization. Therefore, successful obliteration of appropriately selected unruptured aneurysms may reduce the overall socioeconomic burden associated with aneurysmal SAH. However, when contemplating the management of unruptured aneurysms, one must balance the upfront risks of intervention with the long-term risks of surveillance. The optimal follow-up interval for unruptured aneurysm surveillance remains unknown. In addition, the ideal intervention for unruptured aneurysms remains subject to individual and institutional treatment biases. Further studies will need to stratify the risks of surgical and endovascular treatment on the basis of the predicted risk of growth and rupture of an unruptured aneurysm to clarify the optimal management of these patients.

AUTHOR CONTRIBUTIONS
Dr. Dale Ding contributed to the design and conceptualization of the study, analysis and interpretation of the data, and drafting and revising of the manuscript. Dr. Nima Etminan contributed to the design and conceptualization of the study, analysis and interpretation of the data, and revising of the manuscript. Both authors have given final approval of the version to be published.

STUDY FUNDING
No targeted funding reported.

DISCLOSURE
The authors report no disclosures relevant to the manuscript. Go to Neurology.org for full disclosures.

REFERENCES