The Stroke Prognosis Instrument II (SPI-II) : A Clinical Prediction Instrument for Patients With Transient Ischemia and Nondisabling Ischemic Stroke

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The Stroke Prognosis Instrument II (SPI-II)

A Clinical Prediction Instrument for Patients With Transient Ischemia and Nondisabling Ischemic Stroke

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Background and Purpose—In 1991 we developed the Stroke Prognosis Instrument (SPI-I) to stratify patients with transient ischemic attack or ischemic stroke by prognosis for stroke or death in 2 years. In this article we validate and improve SPI-I (creating SPI-II).

Methods—To validate SPI-I, we applied it to 4 test cohorts and calculated pooled outcome rates. To create SPI-II, we incorporated new predictive variables identified in 1 of the test cohorts and validated it in the other 3 cohorts.

Results—For SPI-I, pooled rates (all 4 test cohorts) of stroke or death within 2 years in risk groups I, II, and III were 9%, 17%, and 24%, respectively ($P<0.01$, log-rank test). SPI-II was created by adding congestive heart failure and prior stroke to SPI-I. Each patient's risk group was determined by the total score for 7 factors: congestive heart failure (3 points); diabetes (3 points); prior stroke (3 points); age >70 years (2 points); stroke for the index event (not transient ischemic attack) (2 points); hypertension (1 point); and coronary artery disease (1 point). Risk groups I, II, and III comprised patients with 0 to 3, 4 to 7, and 8 to 15 points, respectively. For SPI-I, pooled rates (3 cohorts excluding the SPI-II development cohort) of stroke or death within 2 years in risk groups I, II, and III were 9%, 17%, and 23%, respectively. For SPI-II, pooled rates were 10%, 19%, and 31%, respectively. In receiver operator characteristic analysis, the area under the curve was 0.59 (95% CI, 0.57 to 0.60) for SPI-I and 0.63 (95% CI, 0.62 to 0.65) for SPI-II, confirming the better performance of the latter.

Conclusions—Compared with SPI-I, SPI-II achieves greater discrimination in outcome rates among risk groups. SPI-II is ready for use in research design and may have a role in patient counseling. **(*Stroke*. 2000;31:456-462.)**

Key Words: cerebral infarction ■ cerebral ischemia, transient ■ cerebrovascular disorders ■ prognosis ■ randomized controlled trials

The ability to know a patient's prognosis with reasonable certainty allows a physician to make informed decisions and to provide counsel on personal matters, diagnostic testing, and therapeutics.[1] Increasingly, prognosis is also used in research planning to stratify clinical trials and identify patients who may be most likely to benefit from therapy. In 1991we published an instrument for estimating the 2-year probability of stroke or death for patients with a recent transient ischemic attack (TIA) or nondisabling ischemic stroke.[2] This instrument, the Stroke Prognosis Instrument I (SPI-I), assigns patients to 3 risk groups (low, medium, high) on the basis of 5 clinical features. During testing in an independent cohort,[2] outcome rates in the 3 risk groups were 10%, 21%, and 59%, respectively ($P<0.001$ by log-rank test). Although we interpreted this validation study as successful (ie, the instrument achieved risk stratification in the independent cohort), other investigators have disagreed.[3] With small numbers of patients (n=142) and outcomes (n=38) in the development cohort, the critics argued that further testing in independent cohorts was needed to establish the reliability of SPI-I (G.J. Hankey, MD, written communication, January 1999).

In an effort to resolve the controversy about SPI-I and to provide further evidence on its reliability, we report in this article the performance of SPI-I in 4 independent cohorts. In addition, we report the results of an effort to revise and

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improve SPI-I. By adding new predictive variables and recalculating point scores for all component variables, we have created SPI-II and demonstrated its enhanced performance in 3 test cohorts.

Subjects and Methods

The Original Stroke Prognosis Instrument (SPI-I)

SPI-I was designed in 1991 to estimate the risk for recurrent stroke or death among patients who have recently (within 90 days) experienced a first carotid territory TIA or nondisabling ischemic stroke.[2] Patients were assigned to 1 of 3 risk groups depending on the presence or absence of 5 factors. Each factor was assigned points determined by its predictive importance: age >65 years (3 points); diabetes (3 points); severe hypertension (2 points); the distinction between stroke and TIA (2 points for stroke); and coronary artery disease (1 point). A patient's total point score determined his or her risk group assignment: 0 to 2 points for group I; 3 to 6 points for group II; and 7 to 11 points for group III.

Retesting the Performance of SPI-I

For the current research, SPI-I was retested in 4 cohorts that were selected to provide a full test of external validity and transportability.[4] Transportability refers to the performance of a prognosis instrument in cohorts other than the one in which it was developed. The first test cohort was the Women's Estrogen for Stroke Trial (WEST).[5] The WEST is an ongoing randomized trial that had recruited 525 patients at the time of this research. SPI-I was used to stratify randomization in this trial, which is being conducted by several of the authors of this article. The other cohorts were from the United Kingdom Transient Ischemic Attack (UK-TIA) Aspirin Trial,[6] the Clopidogrel Versus Aspirin in Patients at Risk of Ischemic Events (CAPRIE) Trial,[7] and the Northern Manhattan Stroke Study (NoMaSS).[8] Because the WEST cohort was most similar to the SPI-I cohort in terms of geography and methodology, we expected that SPI-I would have its best performance in the WEST. The other cohorts were very different from the SPI-I cohort, especially in terms of research methodology used to define baseline variables, and constituted a very rigorous test of transportability.

For each of the 4 cohorts separately, we calculated cumulative rates for stroke or death within 2 years using Kaplan-Meier estimates for study participants classified by SPI-I as having low, medium, or high risk.[9] The log-rank test was used to evaluate differences among time-to-event curves.[10]

For classification of variables in SPI-I among WEST participants, we used the same criteria specified in the original validation study.[2] Diabetes was classified from self-report. Hypertension was defined by blood pressure measurements performed on entry into the WEST. Two readings were recorded from each arm. Severe hypertension was present if the average of any unilateral pair of systolic readings was >180 mm Hg or if the average of any unilateral pair of diastolic readings was >100 mm Hg. The distinction between stroke and TIA was determined by the presence of symptoms lasting >24 hours. Coronary heart disease was determined by self-report of a history of myocardial infarction requiring hospitalization, ECG evidence of a Q-wave myocardial infarction, or a positive Rose Questionnaire for angina.[11] Data on variables required for SPI-I were missing for no patients.

Classification of 3 of 5 variables in SPI-I was similar in all 4 test cohorts: age, the distinction between stroke and TIA for the entry event, and diabetes. Hypertension, however, was classified by a home measurement 3 months after discharge for the WEST (>180 mm Hg systolic or >100 mm Hg diastolic), by hospital measurement for NoMaSS (>180 mm Hg systolic or >100 mm Hg diastolic), by office measurement within 3 months of the index event for the UK-TIA trial, and by self-reported history for CAPRIE. Coronary artery disease was classified by self-reported history of myocardial infarction or ECG criteria for the WEST and NoMaSS, by self-report alone for CAPRIE, and by physician report for the UK-TIA cohort.

Development of an Improved Stroke Prognosis Instrument (SPI-II)

The second goal of our analysis was to improve SPI-I. We used data from the WEST cohort to identify new predictive variables to add to SPI-I.

New candidate variables were identified from several sources. Many were selected because they have been incorporated in other successful prediction instruments.[3,12] These include left ventricular hypertrophy (LVH), peripheral arterial disease, previous stroke or TIA, and the presence of a visible ischemic lesion on brain imaging. On the basis of other published research, we also examined the predictive effect of atrial fibrillation,[13–18] carotid stenosis >80%,[3,19] heart failure,[20–23] and anterior location of myocardial infarction.[24,25] Finally, on the basis of our own hypotheses, we examined physical performance status and cognition.

LVH was defined by the Sokolow-Lyon criteria[26] and separately by a newer sex-specific criterion.[27] Peripheral arterial disease, prior stroke, and prior TIA were defined by patient self-report of a physician diagnosis in a structured interview. Atrial fibrillation was classified by the presence of this rhythm on a baseline ECG or by self-report of a history of the condition. All cases of self-reported atrial fibrillation (with a normal ECG) required confirmation by other medical record documentation. Heart failure was defined by a positive answer by the patient to the question, "Have you ever had shortness of breath or fatigue which your doctor said was due to heart trouble (this is also called heart failure or congestive heart failure)?" Anterior myocardial infarction was defined by the presence of Q waves lasting ≥0.03 seconds in at least 2 of precordial leads V_1, V_2, and V_3. Physical performance was measured with 2 validated instruments.[28,29] Cognition was measured with the Folstein Mini–Mental State Examination.[30] Data were available for >98% of patients for all variables except LVH (available in only 93%), anterior myocardial infarction (available in only 94%), and carotid stenosis (available in only 86%).

For several variables (ie, age, physical functioning, prior cerebrovascular event, hypertension, coronary artery disease, atrial fibrillation, and LVH), we examined several alternative measures. For example, LVH was examined according to both the Cornell[27] and Sokolow-Lyon criteria.[26] To select one among alternative measures to include in a multivariate model, we considered the magnitude of the relative risk (RR) and the statistical significance of the RR. When these criteria did not clearly indicate that one measure was better than another, we kept the original variable definition from SPI-I.

New features were selected for inclusion in the revised instrument if the *P* value for its coefficient was ≤0.1 in a multivariate model. To create the new prognostic system, SPI-II, we assigned points to each variable (the newly selected ones plus the variables in SPI-I) based strictly on the relative magnitude of its regression coefficient in a Cox proportional hazards analysis, with 3 points being the maximum. For each patient in the WEST, we summed the total point score. Risk groups were determined by examining outcome rates in groups of patients with distinct total point scores. Scores demarcating risk groups were selected to combine groups of patients with similar outcome rates.

Validation of SPI-II

To validate SPI-II, we examined its performance in cohorts from the NoMaSS, the UK-TIA Aspirin Trial, and CAPRIE. As a summary measure of the performances of SPI-I and SPI-II, we calculated pooled, weighted estimates of outcome rates in each risk group using EpiMeta software (Klemm Analysis Group, Version 1.1, Centers for Disease Control). Because of significant heterogeneity among studies for outcome rates by risk groups, random effects model estimates are presented. To compare directly the performance of SPI-I and SPI-II, we calculated the area under their receiver operating characteristic (ROC) curves using a spreadsheet program[31] and Lotus 1–2-3 Release 4 for Windows (Lotus Development Corp).

Other data analyses were performed with SAS software (SAS Institute Inc) or SPSS (SPSS Inc). All reported probability values are

TABLE 1. Performance of SPI-I

		Observed Percentages of Stroke or Death Within 2 Years									
		WEST*		UK-TIA*		CAPRIE*		NoMaSS*		All†	
Risk Group‡	Points	n/N	(%)	n/N	(%)	n/N	(%)	n/N	(%)	n/N	(%)
Low	0–2	7/67	(11)	122/1476	(8)	72/929	(9)	5/25	(20)	206/2430	(9)
Middle	3–6	54/352	(18)	136/903	(15)	576/4335	(15)	43/173	(25)	809/5763	(17)
High	7–11	29/106	(32)	9/70	(13)	233/1167	(23)	45/142	(32)	316/1485	(24)

*n/N=(number of patients with the outcome)/(total number in the group). Observed percentages are derived from Kaplan-Meier life table estimates at 24 months following study enrollment. *P* values by the log-rank test for equality of survival curves for each cohort were 0.01 (WEST), 0.008 (UK-TIA), <0.00005 (CAPRIE), and 0.26 (NoMass).

†n/N=(sum of patients with outcomes in risk groups from all 4 cohorts)/(sum of patients in each risk group from all 4 cohorts). Percentages are from a pooled analysis.

‡Each patient's risk group was determined by his or her total point score for 5 factors: age >65 years (3 points), diabetes mellitus (3 points), severe hypertension (2 points), the distinction between stroke and transient ischemia (2 points for stroke), and coronary heart disease (1 point).

2-sided. The WEST was approved by institutional review boards at all participating hospitals, and all subjects gave informed consent.

Results

Performance of SPI-I

Table 1 shows the performance of SPI-I. In the WEST cohort, Kaplan-Meier 2-year percentages for stroke or death in risk groups I, II, and III are 11%, 18%, and 32%, respectively. The trend in rates across risk groups is statistically significant ($P=0.01$, log-rank test). In the UK-TIA cohort, 2-year percentages in risk groups I to III were 8%, 15%, and 13%, respectively ($P=0.008$, log-rank test). In the CAPRIE cohort, percentages were 9%, 15%, and 23% ($P<0.001$, log-rank test), and for NoMaSS, percentages were 20%, 25%, and 32% ($P=0.26$, log-rank test).

The pooled estimates across all 4 cohorts were 9%, 17%, and 24% for risk groups I, II, and III, respectively ($P<0.01$ for linear trend).

Development of SPI-II

Selection of Variables

For an analysis based on the WEST cohort, unadjusted and adjusted RRs for the occurrence of stroke or death within 2 years are listed in Table 2 for all baseline variables. At least 1 definition of the following 6 features was associated with risk for stroke or death in the unadjusted (bivariate) analysis ($P\leq0.05$, log-rank test): physical functioning, prior cerebrovascular event, coronary artery disease, congestive heart failure, atrial fibrillation, and diabetes mellitus.

In a multivariate model, 4 of 13 features were significantly associated with stroke or death ($P\leq0.1$): age >70 years (RR=1.6, $P=0.04$); prior stroke (RR=1.9, $P=0.004$); heart failure (RR=1.5, $P=0.1$); and diabetes (RR=1.7, $P=0.009$). Carotid artery disease was not examined in the multivariate model because data were missing for 74 patients (14%).

Creation of SPI-II

Table 3 displays the regression coefficients from a Cox proportional hazards model and point assignments for variables in SPI-II. Congestive heart failure, diabetes, and prior stroke were each assigned 3 points; age >70 years and stroke (rather than TIA) for the index event were each assigned 2 points; and severe hypertension and coronary artery disease were each assigned 1 point.

The performance of SPI-II in the WEST cohort is shown in Table 4. The 2-year outcome percentage of stroke or death in the first risk group is slightly lower than in SPI-I (9% compared with 11%), but the 2-year percentage in the high-risk group is now 42% compared with 31% originally. The distribution of patients among groups is also more even. By the log-rank test, the trend of rates between risk groups remains statistically significant, with a *P* value of <0.001.

Validation of SPI-II

The performance of SPI-II in 3 independent populations is also shown in Table 4. Most patients in the UK-TIA Aspirin Trial (91%) were in risk group I. Percentages of stroke or death within 2 years in risk groups I, II, and III were 11%, 19%, and 17%, respectively. There were only 6 patients in group III, however, making the estimate of 17% unstable. The trend in rates across risk groups is statistically significant by the log-rank test ($P=0.001$). For the CAPRIE cohort, 2-year outcome percentages for risk groups I, II, and III were 9%, 17%, and 26%, respectively ($P<0.0001$, log-rank test). For NoMaSS, the outcome percentages for risk groups I, II, and III were 16%, 24%, and 42%, respectively ($P=0.0004$, log-rank test).

To compare the performances of SPI-I and SPI-II, Table 5 displays the outcome rates in each risk stratum for each prognosis system pooled across 3 test cohorts (NoMaSS, UK-TIA, and CAPRIE). The WEST cohort is not included in this analysis because it was the development cohort for SPI-II. For SPI-I, the pooled rates in risk groups I, II, and III are 9%, 17%, and 23%, respectively ($P<0.01$ for linear trend). For SPI-II, the pooled rates in risk groups I, II, and III are 10%, 19%, and 31%, respectively ($P<0.01$ for linear trend). The results show that, compared with SPI-I, SPI-II places more patients in the low-risk group and achieves a larger risk increment between risk groups I and III (14% compared with 21%). The values for area under the ROC curve for SPI-I and SPI-II (for the pooled analysis) are 0.59 (95% CI, 0.57 to 0.60) and 0.63 (95% CI, 0.62 to 0.65), respectively.

TABLE 2. Prognostic Effect of Individual Predictors for 525 Patients in the WEST Cohort

		RR for Stroke or Death Within 2 Years	
Feature*	n	Unadjusted†	Adjusted‡
Age			
>65 y	384	1.4	...
>70 y	301	1.5	1.6§
Physical functioning			
Barthel score <19/20	143	1.4	...
Physical Performance Test score ≤22	400	2.0‖	1.3
Cognitive skills			
MMSE score ≤24	72	1.4	1.1
Index event			
Stroke (compared with TIA)	403	1.5	1.3
Infarction on brain imaging			
Infarct on brain imaging	224	1.3	1.0
Carotid artery disease			
>80% carotid artery stenosis	42	1.0	...
Prior cerebrovascular events			
Prior TIA (and no prior stroke)	73	1.0	...
Prior stroke (with or without prior TIA)	105	1.9‖	1.9§
Composite (prior TIA or stroke)	178	1.7‖	...
Hypertension			
Severe hypertension at baseline examination	31	1.1	1.3
History of hypertension	373	1.1	...
Coronary artery disease			
Anterior wall MI on ECG	26	1.6	...
Inferior or lateral MI on ECG	32	1.4	...
Any MI on ECG	58	1.5	...
Self-reported history of MI (and no MI on ECG)	66	1.5	...
Composite (any MI on ECG or by history)	124	1.6‖	1.2
Angina (and no MI on ECG or by history)	29	0.6	...
Myocardial dysfunction			
Self-reported history of heart failure	74	1.8‖	1.5§
Atrial fibrillation			
On baseline ECG	33	2.1‖	1.6
Self-reported only (normal or missing ECG)	50	1.2	...
Composite (either self-report or by ECG)	83	1.5	...
LVH			
Cornell criteria	85	0.9	0.9
Sokolow criteria	25	0.8	...
Diabetes mellitus			
Self-reported history	165	2.0‖	1.7§
Peripheral vascular disease			
Self-reported history	51	1.0	1.1

MMSE indicates Mini–Mental State Examination; MI, myocardial infarction.

*See text for definition of features and references to specific tests.

†Relative risks were derived from Kaplan-Meier survival estimates.

‡Relative Risks were estimated from the regression coefficient in a Cox proportional hazards model. All features in the column were included in the adjusted model. Criteria used to select variables for inclusion in the model are described in the text.

§These features entered a Cox proportional hazards model with $P \leq 0.10$.

‖These features were significant by the log-rank test ($P \leq 0.05$).

TABLE 3. Features Entered into SPI-II

Feature	Adjusted RR for Stroke or Death Within 2 Years	Regression Coefficient	Points
Congestive heart failure	1.8	0.57	3
Diabetes mellitus	1.7	0.55	3
Prior stroke	1.7	0.51	3
Age >70 y	1.6	0.46	2
Stroke (not TIA)	1.5	0.38	2
Severe hypertension	1.2	0.19	1
Coronary artery disease	1.1	0.13	1

Discussion

Our results confirm earlier findings that SPI-I identifies groups of patients with TIA or nondisabling ischemic stroke who are at increased risk for stroke or death.[2] In the pooled analysis involving 4 independent test cohorts, rates of stroke or death within 2 years were 9%, 17%, and 24% for risk groups I, II, and III, respectively.

To improve SPI-I, we built SPI-II by including prior stroke and congestive heart failure. Prior stroke is a well-documented prognostic factor for patients with TIA or stroke.[3,12,13,32] Heart failure has been determined to increase risk for recurrent stroke[20,21,23] or death[22] in some studies but not others.[3,18,33] With the inclusion of prior stroke and congestive heart failure, SPI-II includes most conveniently obtained clinical variables that are well documented to influence the risk for recurrent stroke or death among patients with symptomatic cerebrovascular disease.

Testing of the revised Stroke Prognosis Instrument (SPI-II) in 3 external cohorts confirmed that SPI-II performs better than SPI-I. In the pooled analysis, outcome rates for SPI-II in risk groups I, II, and III were 10%, 19%, and 31%, respectively (Table 5). Patients were more evenly distributed among risk groups in SPI-II than in SPI-I, and the absolute risk distinction between group I and group III was larger for SPI-II (14% compared with 21%). To compare SPI-I and SPI-II with a statistical measure, we calculated the areas under ROC curves. The area was larger for SPI-II than for SPI-I, confirming the better performance of the former.

To demonstrate transportability, we tested SPI-II in 3 cohorts with no foreknowledge of its performance in any of them. We believe that this strategy constituted a formidable test for SPI-II and showed that it transports reasonably well. In CAPRIE and the UK-TIA cohorts, outcome rates in risk groups I and II were similar to rates in the WEST cohort, indicating excellent calibration. Outcome rates in group III, however, were lower than in the WEST. In the NoMass test cohort, the opposite pattern is seen. Calibration is excellent for groups II and III, but the outcome rate was higher for NoMass group I compared with the WEST. Our findings illustrate that the performance (especially calibration) of a prognosis instrument may be affected by how patients are selected for the cohorts in which it is developed and applied.[4] The lower outcome rate in group III from CAPRIE and UK-TIA cohorts may be a consequence of the better overall health and younger age of patients entering those compared with the WEST. The higher outcome rate in group I from NoMass may be a consequence of comorbid illness among the unselected hospital patients who entered this cohort compared with the WEST.

SPI-II had its best performance in the WEST (development) cohort. Beyond patient selection discussed above, we believe that 2 other factors may explain why SPI-II performs better in the WEST cohort than in the other 3. First, the multivariable model used to build SPI-II was fit to the WEST cohort. The superior performance of SPI-II in the WEST cohort is therefore an expected consequence of the analytic strategy used to construct it.[34] Second, baseline variables were acquired by different means and classified according to different criteria in each of the 4 cohorts used to test SPI-II. In some of the cohorts, some variables were defined by self-report or other casual inquiry. Inconsistent or inaccurate

TABLE 5. Pooled, Weighted Rates of Stroke or Death Within 2 Years by Risk Group for SPI-I and SPI-II*

Risk Group	SPI-I		SPI-II	
	No. Pts	Rate	No. Pts	Rate
I	2430	9%†	4725	10%†
II	5411	17%†	3314	19%†
III	1379	23%†	1181	31%†

Pts indicates patients.
*For 3 cohorts: NoMaSS, UK-TIA, CAPRIE.
†$P<0.01$ for trends.

TABLE 4. Performance of SPI-II in 4 Cohorts

		Observed Percentages of Stroke or Death Within 2 Years*							
		WEST		UK-TIA		CAPRIE		NoMaSS	
Risk Group†	Points	n/N	(%)	n/N	(%)	n/N	(%)	n/N	(%)
Low	0–3	13/152	(9)	227/2229	(11)	200/2423	(9)	12/73	(16)
Middle	4–7	45/277	(19)	39/214	(19)	439/2924	(17)	43/176	(24)
High	8–15	34/96	(42)	1/6	(17)	242/1084	(26)	38/91	(42)

*n/N=(number of patients with the outcome)/(total number in the group). Percentages are derived from Kaplan-Meier life table estimates at 24 months following study enrollment. *P* values by the log-rank test for equality of survival curves for each cohort were 0.01 (WEST and UK-TIA), <0.00005 (CAPRIE), and 0.0004 (NoMaSS).

†Each patient's risk group was determined by his or her total point score for 7 factors: factors: congestive heart failure (3 points), diabetes mellitus (3 points), prior stroke (3 points), age >70 years (2 points), stroke for the entry event (compared with TIA) (2 points), severe hypertension (1 point), and coronary artery disease (1 point).

characterization of baseline variables can impair the performance of a prognosis instrument.[4,34] As evidence, the good performance of SPI-I in the WEST cohort may be explained by the fact that WEST variables were defined according to the precise criteria for the SPI-I development set. Testing of SPI-I and SPI-II in cohorts with inconsistent variable characterization allowed us to test transportability to cohorts assembled and characterized with distinct research methods.

Now that SPI-II has been validated in 3 independent cohorts, we believe that it is ready for use in clinical research and possibly ready for use in clinical care. For research, SPI-II can be used to stratify randomization in clinical trials. Stratification can reduce the chance of important imbalances between treatment groups for small (<400 patients) trials and may increase the efficiency of both small and large trials.[35] SPI-I has already been used successfully to stratify randomization in the WEST.[5] SPI-II may also be used to examine treatment effects within randomized controlled trial subgroups defined by prognosis. As an example, a subgroup analysis from the North American Symptomatic Carotid Endarterectomy Trial showed that surgery was associated with a larger RR reduction for ipsilateral stroke among high-risk patients compared with low-risk patients (77% compared with 48%, respectively).[36] Beyond its use for research, SPI-II may be of use for patient counseling. For patients who ask to know their prognosis, SPI-II may provide reassurance for low-risk patients. For higher-risk patients, SPI-II may provide motivation to engage in risk reduction. Until SPI-II is shown to perform as well in population-based cohorts as it does in hospital-based (NoMass) and randomized controlled trial cohorts (WEST, CAPRIE, and UK-TIA), it should be applied only cautiously to individual patients in nonresearch settings.

In addition to SPI-I and SPI-II, 2 other instruments have been published and validated specifically to estimate long-term prognosis for patients with ischemic symptoms.[3,12] One system, developed by Hankey and colleagues,[3] has the form of 3 equations that estimate the probability that an individual patient will be free of various vascular events (stroke; coronary event; stroke, myocardial infarction, or vascular death) at 1 and 5 years. During external validation in the UK-TIA cohort, the authors of this instrument found, as we did in that same validation cohort, that patients estimated by the instrument to be at high risk did not have high outcome rates. The area under the curve for this instrument was 0.65 (95% CI, 0.62 to 0.68), very similar to the area under the curve for SPI-II (0.63; 95% CI, 0.62 to 0.65). Overall, the performances of SPI-II and the system of Hankey et al are quite similar. The reason to use one over the other may be convenience (SPI-II may be easier to apply) and outcomes of interest. The second instrument, by van Latum and colleagues,[12] was developed to predict major vascular events among patients with a TIA or stroke and with atrial fibrillation. The instrument was developed in the placebo group of a randomized controlled trial and applied to the active treatment groups. Thorough performance data were not published. This instrument has not received enough testing to determine its clinical role.

Our research on SPI-I and SPI-II has 3 main limitations. First, both instruments omit stroke type (eg, lacunar infarction, embolic infarction)[37,38] and aortic plaque,[39] 2 baseline variables that may influence prognosis but that were not available in the WEST database. Inclusion of these and other as yet unidentified predictive features may improve the performance of prognosis instruments. Second, our instruments were developed and tested in research cohorts. How they transport to nonresearch cohorts is unknown. Third, SPI-I and SPI-II were applied retrospectively to most of our test cohorts (SPI-I was applied prospectively to the WEST cohort). We believe that they both will perform optimally only with prospective application that allows optimal baseline variable classification.

Progress in clinical prediction for stroke patients will come by identifying clinical features that sharply discriminate between those who suffer a subsequent vascular event and those who do not and by applying appropriate research methods for the development of multivariable instruments. SPI-II includes most clinical features of known predictive importance and was developed with rigorous research methods. It is convenient to use, compares favorably with available prediction instruments, and targets a distinctly important clinical outcome. Although SPI-II represents progress, like all prediction instruments it will need to be reinvented or recalibrated periodically to reflect how therapy and temporal trends in population health affect disease outcome.

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