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Original Contribution

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Javier M. Romero, MD; H. Bart Brouwers, MD; JingJing Lu, MD; Josser Delgado-Almondoz, MD; Hillary Kelly, MD; Jeremy Heit, MD, PhD; Joshua Goldstein, MD, PhD; Jonathan Rosand, MD, MSc; R. Gilberto Gonzalez, MD, PhD

Background and Purpose—Intracerebral hemorrhage (ICH) results in high mortality and morbidity for patients. Previous retrospective studies correlated the spot sign score (SSSc) with ICH expansion, mortality, and clinical outcome among ICH survivors. We performed a prospective study to validate the SSSc for the prediction of ICH expansion, mortality, and clinical outcome among survivors.

Methods—We prospectively included consecutive patients with primary ICH presenting to a single institution for a 1.5-year period. All patients underwent baseline noncontrast computed tomography (CT) and multidetector CT angiography performed within 24 hours of admission and a follow-up noncontrast CT within 48 hours after the initial CT. The ICH volume was calculated on the noncontrast CT images using semiautomated software. The SSSc was calculated on the multidetector CT angiographic source images. We assessed in-hospital mortality and modified Rankin Scale at discharge and at 3 months among survivors. A multivariate logistic regression analysis was performed to determine independent predictors of hematoma expansion, in-hospital mortality, and poor clinical outcome.

Results—A total of 131 patients met the inclusion criteria. Of the 131 patients, a spot sign was detected in 31 patients (24%). In a multivariate analysis, the SSSc predicted significant hematoma expansion (odds ratio, 3.1; 95% confidence interval, 1.77–5.39; $P \leq 0.0001$), in-hospital mortality (odds ratio, 4.1; 95% confidence interval, 2.11–7.94; $P \leq 0.0001$), and poor clinical outcome (odds ratio, 3; 95% confidence interval, 1.4–4.42; $P=0.004$). In addition, the SSSc was an accurate grading scale for ICH expansion, modified Rankin Scale at discharge, and in-hospital mortality.

Conclusions—The SSSc demonstrated a strong stepwise correlation with hematoma expansion and clinical outcome in patients with primary ICH. **(*Stroke*. 2013;44:00-00.)**

Key Words: CT angiography ■ intracerebral hemorrhage ■ mortality ■ spot sign ■ stroke

Primary intracerebral hemorrhage (ICH) is a subtype of stroke that affects >1 million people worldwide annually and accounts for 10% to 15% of all strokes.[1] ICH has a mortality of 30% to 50%, which exceeds the mortality of ischemic stroke.[2] Many scoring systems have been developed, integrating demographic, clinical, and radiological features to stratify mortality risk in patients with ICH.[3–5] Radiological findings, such as larger ICH volume,[3,6] presence of intraventricular hemorrhage,[7–9] higher spot sign score (SSSc),[10,11] and ICH expansion,[12–14] may help predict which patients will have clinical deterioration and worse outcome. A better method for early detection of patients with increased risk of ICH expansion could identify a group at high risk that would be most likely to benefit from hemostatic therapy, intensive blood pressure reduction, or rapid surgical evacuation. Multiple groups have shown that the multidetector computed tomographic angiography (MDCTA) spot sign predicts hematoma expansion and poor outcome.[10,11,15–17] A recent large, multicenter, prospective study demonstrated that although spot sign is a validated predictor of hematoma expansion and clinical outcome, its sensitivity and specificity were imperfect.[18] The SSSc incorporates radiological markers (spot sign number, density, and size) that yield information on the simple presence or absence of contrast extravasation. These characteristics represent larger concentrations of extravasated contrast and may well identify patients with higher bleeding rate. The SSSc had a strong stepwise correlation with hematoma expansion and clinical outcome.[10] Therefore, to validate the ability of SSSc to provide more information than the dichotomous presence/absence of a spot sign, we performed a prospective single-center study.

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From the Department of Radiology (J.M.R., H.K., J.H., R.G.G.), Department of Emergency Medicine (J.G.), and Department of Neurology (H.B.B., J.R.), Massachusetts General Hospital, Harvard University, Boston, MA; Department of Radiology, Peking Union Medical College Hospital, Beijing, China (J.L.); and Department of Interventional Neuroradiology, Neuroscience Institute, Abbott Northwestern Hospital, Minneapolis, MN (J.D.-A.).

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Correspondence to Javier M. Romero, MD, Department of Radiology, Massachusetts General Hospital, Harvard University, 55 Fruit St, GRB, Office #279, Boston, MA 02114. E-mail Jmromero@partners.org

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Materials and Methods

Patient Selection/Enrollment

Our study was approved by the Institutional Review Board of the hospital and complied with Health Insurance Portability and Accountability Act regulations. From January 2009 to June 2010, we prospectively collected data on all patients with primary ICH who were admitted to the emergency department of Massachusetts General Hospital. The patient eligibility criteria included (1) evidence of nontraumatic ICH based on a noncontrast CT examination (NCCT) of the head performed at the time of admission; (2) an MDCTA performed within 24 hours of admission; and (3) a follow-up NCCT within 48 hours of the baseline image. Patient exclusion criteria included the presence of (1) an associated subarachnoid hemorrhage in the basal cisterns; (2) a vascular lesion or neoplasia determined as the cause for the ICH, identified by CT angiography, conventional angiography, or MRI; (3) a loss of gray–white matter differentiation in a vascular territory, suggesting a pre-established acute ischemic stroke or venous infarct; (4) a hematoma drainage between the baseline NCCT and the follow-up NCCT; or (5) a nondiagnostic CT image.

Image Acquisition

NCCT acquisitions were performed according to the standard departmental protocols on a 64-section General Electric helical CT scanners (LightSpeed; GE Medical Systems, Waukesha, WI). NCCT examinations were performed using helical technique with 120 to 140 kVp, auto mA (10–500), and 5-mm slice thickness reconstruction. MDCTA was subsequently performed by scanning from the base of the C1 vertebral body to the vertex using axial technique, 0.5 pitch, 1.25-mm collimation, 235 mA, 120 kVp, 22-cm field of view, and 65 to 85 mL of iodinated contrast material administered by a power injector at 4 to 5 mL/s into an antecubital vein with either a fixed 25-second delay between the onset of contrast injection and the start of scanning or Smart-Prep, a semiautomatic contrast bolus triggering technique. Internal guidelines of our stroke service recommend an immediate follow-up with an NCCT of the head if there is neurological deterioration (>2 points on the National Institutes of Health Stroke Scale) and a follow-up NCCT in 24 hours if the patient is stable. MDCTA and NCCT acquisition were both performed on the same hardware platform (Light Speed; GE Healthcare, Milwaukee, WI) and using the same protocol as previously published.[19]

Image Analysis

The NCCT images were reviewed by 2 experienced neuroradiologists (J.M.R. and J.J.L.). Determination of the initial and follow-up volumes of intraparenchymal hematoma and intraventricular hematoma (IVH) was performed independently with Analyze 10.0 software (Mayo Clinic, Rochester, MN). Volumes were measured with manual tracing of the ICH outline on the baseline and first follow-up NCCT images. A 6 mL or 33% ICH enlargement was considered significant expansion.[15,20] Average rate of expansion was calculated by subtracting the initial ICH volume from the follow-up ICH volume and dividing the product by the interval (hours) between the 2 examinations.

Spot Sign Detection and Score Calculation

MDCTA source images were independently reviewed in spot windows (width 200, level 110) by the same 2 neuroradiologists to determine the presence of active contrast extravasation, the spot sign, according to the following strict radiological criteria: (1) ≥1 focus of contrast pooling within the ICH; (2) with an attenuation ≥120 Hounsfield units; (3) discontinuous from normal or abnormal vasculature adjacent to the ICH; and (4) of any size and morphology.[10] The SSSc was calculated on the basis of the number of spot signs, maximum dimension in a single axial MDCTA source image, and maximum absolute attenuation[10] (Supplement I in the online-only Data Supplement).

Independent Variables

Patient medical records were reviewed on admission for age, sex, and mean arterial blood pressure to screen for hypertension, which was verified by the evidence of a documented history of hypertension either from 2 physician-generated measurements or patient's use of antihypertensive medication. Patients were divided into 2 groups on the basis of blood glucose levels, either >170 mg/dL or <170 mg/dL. In addition, coagulation status was evaluated with the international normalized ratio, prothrombin time, parcial thromboplastin time, and modifying treatments, such as antiplatelet therapy, anticoagulation therapy, administration of fresh frozen plasma, vitamin K, and platelet transfusion on admission. Patients underwent a full neurological examination, and a modified Rankin Scale (mRS) was determined. This examination was repeated at discharge and at 3 months to determine the mRS. If the mRS at 3-month follow-up was not available, the last clinical observation or discharge mRS was used.

Patients with an mRS score of <3 were considered to have a good outcome, whereas those with an mRS of ≥3 were classified under the poor outcome category.[15] This scale also included mortality, with dead patients receiving the worst possible score of 6.

Statistical Analysis

Statistical analysis was performed using SAS version 9.1 software package (SAS Institute Inc). All variables including age, sex, hypertension, high blood glucose, warfarin or aspirin use, IVH, SSSc, and ICH volume were recorded and compared using univariate analysis to find possible significant predictors for the outcome under evaluation. The level of significance was set at 2-sided $P<0.05$ for all statistical analyses. Those variables that reached $P<0.05$ in univariate analysis were considered for multivariable analysis. Multivariate logistic regression analysis and linear regression for continuous variables were performed to determine independent predictors of ICH expansion and poor clinical outcome. The receiver operating characteristic analysis was used to determine the area under the curve for the average rate of expansion in the prediction of poor clinical outcome at the 3-month follow-up.

Results

During a period of 1.5 years, a total of 213 patients were presented to our emergency department with nontraumatic ICH on an NCCT. Of the 213 patients, 82 were excluded from the study: 52 had a vascular lesion or neoplasia as the cause of ICH; 4 showed loss of gray–white matter differentiation in a vascular territory, suggesting a pre-established acute ischemic stroke or venous infarct; 24 underwent ICH drainage immediately after NCCT; and 2 had incomplete hematoma imaging.

A total of 131 patients met our eligibility criteria, with a mean age of 71.5 years (median, 74 years; range, 26–99 years). Of the 131 patients, 24 (18%) were using warfarin at time of presentation and 46 (35%) were using antiplatelet. Forty-eight patients (36.6%) had intraventricular extension of their ICH. ICH growth of 6 mL or >33% was detected in 25 patients (19%). A total of 28 patients died during the hospital stay (21%). Among the 106 survivors, 52 patients had poor outcome at 3-month follow-up (49%; Table 1).

A spot sign was detected in 31 (24%) patients: 18 (58%) males and 13 (42%) females. A spot sign was detected in 19 (68%) of the 28 patients who died in the hospital and in 28 (36%) of the patients who had poor clinical outcome at 3 months. The presence of any spot sign had an overall sensitivity of 64%, specificity of 86%, positive predictive value of 0.52, and negative predictive value of 0.91 for significant ICH expansion. The spot sign demonstrated a sensitivity of 68%, a specificity of 88%, a positive predictive value of 0.61, and a

Table 1. Baseline Characteristics of the Population (n=131)

Parameters	
Age, mean±SD (median), y	71.5±15 (74)
Sex, n (%)	
Female	52 (39)
Male	79 (61)
History of hypertension	92 (70%)
Admission MABP, mean±SD, mm Hg	113±28
Glucose, mean±SD, mg/dL	143.5±51.7
Glucose ≤170	69 (53%)
Glucose >170	62 (47%)
Platelets, mean±SD, thousands/μL	246±78
Anticoagulation	Yes 24 (18%)
	No 107 (82%)
INR, mean±SD	1.28±0.96
Antiplatelet medication	Yes 46 (35%)
	No 85 (65%)
Infusion of platelets on admission	Yes 12 (9%)
Administration of vitamin K on admission	Yes 19 (14%)
Infusion of fresh frozen plasma on admission	Yes 17 (13%)
Initial ICH volume, mean±SD, mL	26.1±28
Presence of IVH	48 (36.6%)
Time of ED arrival to CT, mean±SD, h	2.1±2.8
Time of onset to follow-up CT, mean±SD, h	13.7±8.7
Admission ICH volume, median, mL	14.9
Follow-up ICH volume, mean±SD, mL	29.2±33.6
Follow-up ICH volume, median, mL	15.1
In-hospital mortality	28 (21%)
Discharge mRS	3.54±1.67
Three-month mRS	3.14±2.01
Average rate of ICH expansion, mean±SD, mL/h	0.62±2.8
Spot sign	31 (24%)
Score	
0	100 (76%)
1	14 (11%)
2	11 (8%)
3	4 (3%)
4	2 (1.5%)

CT indicates computed tomography; ED, emergency department; ICH, intracerebral hemorrhage; INR, international normalized ratio; IVH, intraventricular hemorrhage; MABP, mean arterial blood pressure; and mRS, modified Rankin scale.

negative predictive value of 0.91 for in-hospital mortality. The spot sign had a sensitivity of 34%, a specificity of 94%, a positive predictive value of 0.90, and a negative predictive value of 0.5 for the prediction of a poor clinical outcome among survivors (mRS>3).

Predictors of In-Hospital Mortality and mRS at 3 Months

Table 2 shows univariate analyses of predictors of in-hospital mortality and mRS at 3 months. Age, prolonged international normalized ratio at admission, admission ICH volume, follow-up ICH volume, spot sign, SSSc, presence of IVH, average rate of ICH expansion, and time from emergency department admission to first CT were associated with in-hospital mortality.

Multivariate Analysis of ICH Expansion

The multivariate model for ICH expansion included age, ICH volume, IVH, glucose >170, SSSc, high blood pressure, and anticoagulation. Initial ICH volume (P=0.0002), SSSc (P≤0.0001), and glucose >170 (P=0.01) were the remaining independent predictors of ICH expansion (Table 3). Higher SSScs demonstrate increased specificity to predict significant hematoma expansion (Table 4).

Independent Predictors of In-Hospital Mortality in Primary ICH in Multivariate Analysis

Patient age (P=0.0002), average rate of ICH expansion (P=0.0032), SSSc (P≤ 0.0001), IVH (P=0.01), and admission ICH volume (P=0.0002) were independent predictors of in-hospital mortality of patients with primary ICH (Table 3).

Independent Predictors of Poor Clinical Outcome (mRS>3) at 3 Months

In a multivariate analysis, an association was found between age (P=0.02), average rate of ICH expansion (P=0.0015), SSSc (P=0.04), IVH (P=0.002), and initial ICH volume (P=0.047) and mRS at 3 months (Table 3). The Figure demonstrates a stepwise association of the SSSc and the mRS at 3 months. Furthermore, all patients with an SSSc of 3 or 4 had a poor clinical outcome.

SSSc and the Risk of ICH Expansion and Mortality

A stepwise risk of ICH expansion and mortality was seen with an increasing SSSc (Supplement II and III in the online-only Data Supplement).

Discussion

This study prospectively validates the SSSc as a predictor of ICH expansion, mortality, and poor clinical outcome after primary ICH. Our data suggest that the SSSc categorizes expansion and mortality risk in a stepwise fashion for those patients with a positive spot sign.

The recent failure of procoagulant medications[20] and surgery[16,21] for ICH treatment has sparked interest in methods that detect ICH patients who are actively bleeding in order to select those patients at highest a priori risk of mortality and poor functional outcome. Unfavorable results from the recent Intensive Blood Pressure Reduction in Acute Cerebral Haemorrhage Trial (INTERACT) II demonstrated no significant reduction in the primary outcome of rate of death or severe disability. The trial demonstrated improvement of the ordinal modified Rankin scores in the intensive lowering of blood pressure group.[18] ICH contrast extravasation,[17] later known as the spot sign,[15] has been associated in multiple studies with ICH expansion, likely reflecting active bleeding. In 2012, Demchuk et al[22] prospectively demonstrated the positive correlation of the presence of a spot sign and the risk of ICH expansion and

Table 2. Potential Predictors of In-Hospital Mortality and Three Months' Outcome

	Comparison of Patients Survived vs Deceased at Discharge			Comparison of Patients With Good vs Poor Outcomes		
	Survived (n=103)	Deceased (n=28)	*P* Value	Good Outcome (mRS<3; n=53)	Poor Outcome (mRS≥3; n=78)	*P* Value
Age, mean±SD, y	70±16	77±16	0.05*	70±16	72±16	0.45*
Sex						
Male	59%	64%	0.63†	64%	58%	0.46†
Female	41%	36%		36%	42%	
History of hypertension	68/103 (66%)	22/28 (79%)	0.20†	33/53 (62%)	57/78 (73%)	0.15†
SBP at admission, mm Hg	165±38	180±46	0.09*	156±38	176±40	0.01*
DBP at admission, mm Hg	84±23	92±32	0.13*	80±21	90±28	0.03*
Glucose, mean±SD, mg/dL	145±56	139±39	0.59 *	138±47	147±57	0.30*
Platelets, mean±SD	245±69	252±103	0.65*	238±68	252±83	0.30*
Anticoagulation	14/103 (14%)	8/28 (29%)	0.09†	7/53 (13%)	15/78 (19%)	0.65†
Antiplatelet medication	34/103 (33%)	12/28 (43%)	0.33†	19/53 (36%)	27/78 (35%)	0.89†
INR, mean±SD	1.2±0.5	1.6±0.8	0.05*	1.2±0.4	1.3±0.7	0.11*
Vitamin K	12/103 (12%)	7/28 (25%)	0.13‡	5/53 (9%)	14/78 (18%)	0.21‡
Platelet transfusion	8/103 (8%)	4/28 (14%)	0.28‡	3/53 (6%)	9/78 (12%)	0.36‡
Fresh frozen plasma	11/103 (11%)	6/28 (21%)	0.20‡	7/53 (13%)	10/78 (13%)	1.00‡
Admission ICH volume, mean±SD, mL	20.0±20.7	48.6±39.1	0.001*	15.3±14.3	33.5±32.6	<0.0001*
Follow-up ICH volume, mean±SD, mL	20.5±21.1	61.6±48.9	<0.0001*	15.1±14.3	38.9±39.3	<0.0001*
Presence of IVH	29/103 (28%)	19/28 (68%)	<0.0001†	8/53 (15%)	40/78 (51%)	<0.0001†
Time of admission to first CT, mean±SD, h	2.4±3.0	0.9±0.6	<0.0001*	2.7±3.2	1.7±2.4	0.02*
Time of first CT to follow-up CT, mean±SD, h	14.7±8.7	11.7±8.6	0.12*	14.1±7.3	14.0±9.7	0.97*
Admission ICH volume, median, mL	12.7	38.5	<0.0001§	9.5	18.6	<0.0001§
Follow-up ICH volume, median, mL	13.0	64.9	<0.0001§	10.5	18.7	<0.0001§
Spot sign presence	12/103 (12%)	19/28 (68%)	<0.0001†	3/53 (6%)	28/78 (36%)	0.0002†
SS Score						
0	91	9	<0.0001†	50	50	0.1483†
1	7	7	0.0057†	2	12	0.0347†
2	4	7	0.0004†	1	10	0.0269†
3	1	3	0.0079†	0	4	0.0943†
4	0	2	0.0063†	0	2	0.2401†
Average rate of ICH expansion, mean±SD, mL/h	0.03±0.39	2.81±5.55	0.01*	−0.04±0.33	1.07±3.55	0.01*

DBP indicates diastolic blood pressure; ICH, intracerebral hemorrhage; INR, international normalized ratio; IVH, intraventricular hemorrhage; mRS, modified Rankin scale; SBP, systolic blood pressure; and SS, spot sign.

*Student *t* test.

†χ^2 Test

‡Fisher exact test.

§Mann–Whitney test.

poor clinical outcome in a cohort of 228 adult patients. The sensitivity of the spot sign to predict ICH expansion in this study was lower (51%) than previous retrospective results (88%–93%).[23–25] We found that the spot sign had a sensitivity of 68% for the prediction of ICH expansion, which is slightly higher than the results of the Prediction of haematoma growth and outcome in patients with intracerebral haemorrhage using the CT-angiography spot sign (PREDICT) trial. Decreased sensitivity of the spot sign in these prospective trials may be technical and secondary to differences in scanner speed. Most of the previous retrospective studies scanned a large proportion of their patients on 4-, 16-, and 64-slice scanners,[15,17,26] and not on the new faster scanners with 128- and 320-slice scanners. Recent articles highlight the importance of the delay between contrast administration and imaging on the appearance of the spot sign.[23,27] Future research should take into account delayed imaging to improve sensitivity in the detection of the spot sign. We detected a spot sign in 31 (24%) patients, which is similar to the percent detected in previous studies,[24,26] including the PREDICT trial,[22] in which a spot sign was detected in 30% of their patients. Although multiple studies had different time intervals between ictus and imaging, the presence of the spot sign remained constant within a 20% to 30% range.[18,25]

The spot sign scoring system captures the morphological and physical properties of iodinated contrast that reflect the concentration and volume of contrast extravasated. This

Table 3. Multivariate Analysis of Predictors (n=131)

	ICH Expansion		In-Hospital Mortality		(mRS≥3) at 3 mo	
Variable	OR (95% Wald CI)	*P* Value	OR (95% Wald CI)	*P* Value	OR (95% Wald CI)	*P* Value
Age, y	1.0 (0.76–1.43)	0.76	1.61 (1.10–2.38)	0.002	1.49 (1.06–2.10)	0.02
Average rate of expansion	N/A*	N/A*	3.69 (1.55–8.77)	0.0032	12.99 (2.68–62.5)	0.0015
Spot sign score	3.1 (1.77–5.39)	<0.0001	4.1 (2.11–7.94)	<0.0001	3 (1.4–4.42)	0.004
IVH	1.0 (0.25–4.1)	0.9671	4.89 (1.74–13.33)	0.002	4.89 (1.74–13.33)	0.002
Glucose >170	3.5 (1.069–11.74)	0.03	0.487 (0.08–2.68)	0.40	0.739 (0.18–2.91)	0.66
Anticoagulation	1.02 (0.25–4.18)	0.97	1.99 (0.46–8.55)	0.35	1.51 (0.41–5.62)	0.53
Hypertension	3.1 (0.68–14.84)	0.1416	1.405 (0.19–10.30)	0.73	2.022 (0.42–9.62)	0.37
Admissions ICH volume		0.0002		0.0002		0.002
<30 mL	1		1		4.89 (1.74–13.33)	
30–60 mL	3.5 (3.21–3.8)		3.5 (3.21–3.8)		1	
>60 mL	15.68 (4.18–58.89)		15.68 (4.18–58.89)		1.05 (0.93–1.18)	

Forty patients did not have a 3-mo modified Rankin scale (mRS) evaluation, and the last in-hospital mRS was included in this model. CI indicates confidence interval; ICH, intracerebral hemorrhage; IVH, intraventricular hemorrhage; and OR, odds ratio.

*Only measured on patients who expanded.

method was previously evaluated in a retrospective study[24] that demonstrated not only a stepwise risk of hematoma expansion, but also predicted the degree of the ICH expansion, mortality, and poor functional outcome. We have now prospectively replicated these results demonstrating that increased SSScs reflect higher risk of hematoma expansion and mortality. Therefore, SSScs may allow early detection of patients with ICH that may be an ideal target for hemostatic therapy and acute surgical intervention, particularly when a reliable neurological examination is unavailable. With the likelihood of new hemostatic drugs and minimally invasive surgical treatments being evaluated in prospective clinical trials for ICH,[28] the identification of a surrogate marker for poor clinical outcome and mortality based on CT angiography on admission is an important objective. In contrast to the simple presence or absence of the spot sign, the SSSc is able to stratify patients' risk of poor clinical outcome and increase the specificity of the spot sign (Table 4).

Among the multiple variables we evaluated, initial ICH volume is considerably the strongest predictor of mortality within the group. This is particularly robust in patients with ICH of >60 mL as demonstrated by Broderick et al.[6] Our study, as many previous ones, also detected a high positive predictive value for initial ICH volume,[3,5,6,13] and intraventricular hemorrhage[11,14,29] for mortality.

The SSSc improves the differentiation of patients who will expand as well as those who will have poor outcome. This is especially important for patients who may require invasive treatments in which certainty of active bleeding is critical. In this study, we validate the SSSc as an accurate grading scale for ICH expansion and clinical outcome.

Conclusions

Our results show a strong stepwise association of the SSSc with both hematoma expansion and poor clinical outcome among patients with primary ICH. The SSSc provides a dynamic selection tool for clinical decision making and patient selection for trials and treatment.

Disclosures

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Table 4. Correlation of the Spot Sign Score and ICH Expansion (>6 mL or 33%)

SCORE	SENS	95% CI	SPEC	95% CI
≥0	100	93.6–100	0	0–1.2
≥1	87.5	75.9–94.8	92.9	89.5–95.5
≥2	76.8	63.6–87	96.8	94.2–98.4
≥3	60.7	46.8–73.5	99.7	98.2–100
≥4	30.4	18.8–44.1	100	98.8–100
AUC	0.93	0.89–0.95		
P Value	<0.0001			

AUC indicates area under the curve; CI, confidence interval; ICH, intracerebral hemorrhage; SENS, sensitivity; and SPEC, specificity.

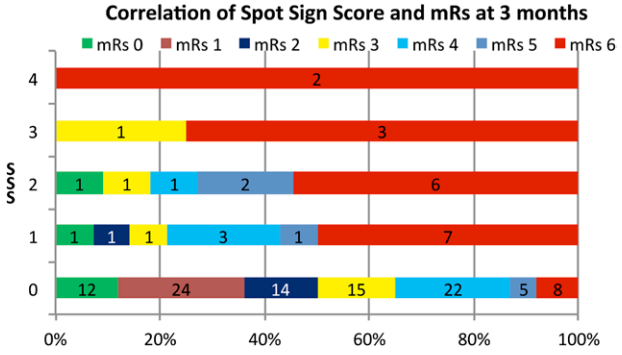

Figure. Correlation of spot sign score and modified Rankin scale (mRs) at 3 months after discharge.

is on the Imaging Committee Desmoteplase in Acute Ischemic Stroke Trial (DIAS) trial and is on the advisory board of Lundbeck Pharmaceuticals. Dr Rosand receives research grants from NIH. The other authors have no conflict to report.

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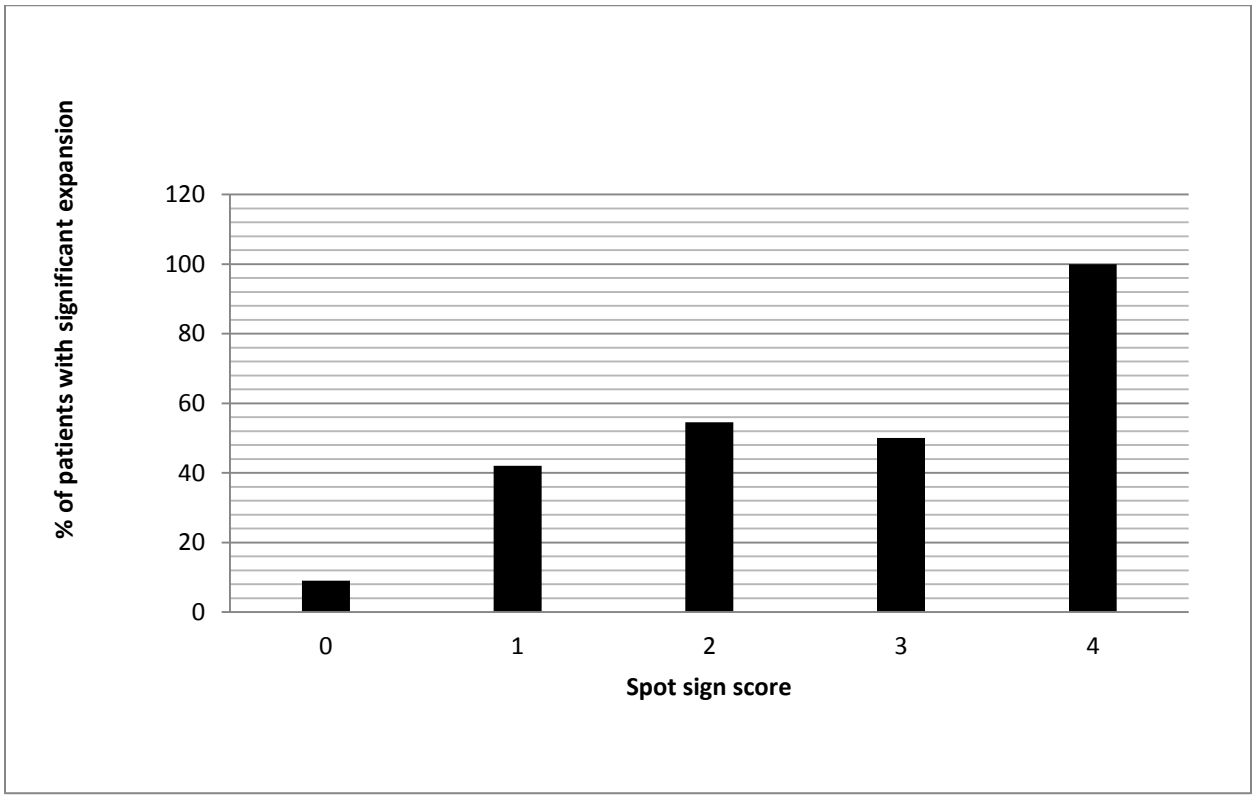
SUPPLEMENTAL MATERIAL

Supplement I. Spot sign score

Spot Sign Characteristics*	Points
No of spot signs	
1-2	1
≥3	2
Maximum axial dimension	
1-4 mm	0
≥5mm	1
Maximum attenuation	
120-179 HU	0
180 HU	1

*The spot sign characterization is performed in the first CTA acquisition in which a spot sign is identified. For CTA's with more than 1 spot sign, the maximum dimension in a single axial CTA source image and maximum attenuation of the largest spot sign is determined. The spot sign score is obtained by adding up the total number of points. HU indicates Hounsfield unit; CTA, CT angiogram.

Supplement II. Correlation of Spot Sign score with the percent of patients with a significant ICH expansion.



Supplement III. Correlation of the Spot Sign score with mortality (% of patients) at 3months.