Journal of Patient-Centered Research and Reviews

Volume 9 | Issue 2 Article 3

4-18-2022

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Kessarin Panichpisal
Sarah Erpenbeck
Paul Vilar
Reji P. Babygirija
Maharaj Singh
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Richard A. Rovin

Recommended Citation

Panichpisal K, Erpenbeck S, Vilar P, Babygirija RP, Singh M, Colella MR, Rovin RA. Stroke Network of Wisconsin (SNOW) scale predicts large vessel occlusion stroke in the prehospital setting. J Patient Cent Res Rev. 2022;9:108-16. doi: 10.17294/2330-0698.1892

Published quarterly by Midwest-based health system Advocate Aurora Health and indexed in PubMed Central, the Journal of Patient-Centered Research and Reviews (JPCRR) is an open access, peer-reviewed medical journal focused on disseminating scholarly works devoted to improving patient-centered care practices, health outcomes, and the patient experience.

Stroke Network of Wisconsin (SNOW) Scale Predicts Large Vessel Occlusion Stroke in the Prehospital Setting

Kessarin Panichpisal, MD,[1] Sarah Erpenbeck, BS,[2] Paul Vilar, MSN, SCRN,[1] Reji P. Babygirija, MS,[3] Maharaj Singh, PhD,[4,5] M. Riccardo Colella, DO, MPH,[6] Richard A. Rovin, MD[1]

[1]Aurora Neuroscience Innovation Institute, Advocate Aurora Health, Milwaukee, WI; [2]University of Pittsburgh School of Medicine, Pittsburgh, PA; [3]University of Wisconsin-Madison, Madison, WI; [4]Advocate Aurora Research Institute, Advocate Aurora Health, Milwaukee, WI; [5]Marquette University, Milwaukee, WI; [6]Milwaukee County Office of Emergency Management, Milwaukee, WI

Purpose In previous trials, the Stroke Network of Wisconsin (SNOW) scale accurately predicted large vessel occlusion (LVO) stroke in the hospital setting. This study evaluated SNOW scale performance in the prehospital setting and its ability to predict LVO or distal medium vessel occlusion (DMVO) in patients suspected of having acute ischemic stroke (AIS), a scenario in which transport time to an endovascular treatment-capable facility (ECSC) is critical.

Methods All potential AIS patients with last-known-well time of ≤24 hours were assessed by Milwaukee County Emergency Medical Services for LVO using SNOW. Patients with a positive SNOW score were transferred to the nearest ECSC. One such facility, Aurora St. Luke's Medical Center (ASLMC), was the source of all patient data analyzed in this study. LVO was defined as occlusion of the intracranial carotid artery, middle cerebral artery (M1) segment, or basilar artery.

Results From March 2018 to February 2019, 345 AIS-suspected patients were transported to ASLMC; 19 patients were excluded because no vascular imaging was performed. Of 326 patients, 32 had confirmed LVO and 21 DMVO. For identifying LVO, SNOW scale sensitivity was 0.88, specificity 0.40, positive predictive value (PPV) 0.14, negative predictive value (NPV) 0.97, and area under the curve (AUC) 0.64. Ability to predict DMVO was similar. Overall, the SNOW scale showed sensitivity of 0.83, specificity of 0.39, PPV of 0.10, NPV of 0.97, and AUC of 0.60 in identifying candidates for endovascular thrombectomy.

Conclusions In a prehospital setting, the SNOW scale has high sensitivity in identifying candidates for endovascular thrombectomy and proved highly reliable in ruling out stroke due to LVO. (*J Patient Cent Res Rev.* 2022;9:108-116.)

Keywords SNOW scale; large vessel occlusion; LVO; prehospital screening; acute ischemic stroke; endovascular thrombectomy

Although proximal large vessel occlusion (LVO) accounts for approximately 35%–40% of acute ischemic stroke (AIS), it accounts for more than 95% of mortality. Of those patients who survive, more than 60% will experience poststroke disability. Both real-world and large-registry data consistently demonstrate a worse outcome in patients whose transfer and subsequent reperfusion treatment is delayed.[2,3] A delay of even 30 minutes results in a 12%–15% loss in angiographic reperfusion, as well as the inability to carry out usual activities (modified Rankin score of >2),[4] and although intravenous thrombolysis is available in most hospitals, endovascular thrombectomy (EVT) is restricted to endovascular treatment-capable stroke centers (ECSC). EVT treatment has been shown to reduce disability of patients with an LVO at the 90-day follow-up as compared with control patients,[5] even in patients treated at 16–24 hours.[6] For this reason, rapid triage of patients with AIS and suspected LVO to an ECSC is critical, yet highly dependent on a simple, fast, and sensitive prehospital predictor of LVO.

Corresponding author: Richard A. Rovin,
Aurora St. Luke's Medical Center, 2801 W. Kinnickinnic River Pkwy., #680, Milwaukee, WI 53215 (richard.rovin@aah.org)

Patients presenting with distal medium vessel occlusion (DMVO) make up between 25% and 40% of stroke cases, depending on available data.[7,8] Although the mortality rate is significantly lower (24%) for patients with DMVO than with LVO, the rate of functional disability associated with DMVO ranges from 60% to 77% in patients with M2 or proximal occlusions (eg, in anterior or posterior cerebral artery).[9] In addition, intravenous fibrinolytics fail to recanalize 66% of DMVO.[10] Although EVT treatment for patients with a DMVO is still fairly new and under some debate,[10] recent trials have shown increased reperfusion.[11,12] Therefore, ability to predict DMVO in addition to LVO would be beneficial.

Historically, the most commonly used predictor was the National Institutes of Health Stroke Scale (NIHSS), which was made up of 11 items (Table 1). Currently, an abundance of screening tools are in use: Los Angeles Motor Scale (LAMS),[13] Rapid Arterial Occlusion Evaluation (RACE),[14] Cincinnati Stroke Triage Assessment Tool (C-STAT),[15,16] Facial palsy, Arm weakness, Speech changes, Time, Eye deviation, Denial/neglect (FAST-ED) scale,[17] Vision, Aphasia, Neglect (VAN) score,[18] Prehospital Acute Stroke Scale (PASS),[19] and the Gaze, Face, Arm, Speech, Time (G-FAST) scale.[20] Although most prediction scales are heavily based on motor deficits (LAMS, C-STAT G-FAST), tools focusing on motor deficits are less reliable for predicting LVO[21] due to the fact that multiple lesion sites may be responsible for the observed deficit(s). Additionally, inclusion of neuropsychological symptoms when predicting LVO has been shown to yield significantly better predictive sensitivity and selectivity.[21] In contrast, RACE, VAN, and PASS all incorporate neglect or aphasia as part of their screening.[14,18,19] Recently, RACE and LAMS were found to be effective for predicting LVO in the prehospital setting;[22] however, RACE is composed of 5 elements scored with a 3-point scale involving right-/left-side specification. LAMS, with a sensitivity of 0.74, does not include discriminating cortical findings and can be subjective.[21,23] Together, these findings point to a continuing need for an LVO prediction tool that is fast, simple, and utilizes neuropsychological symptoms.

We have previously described the Stroke Network of Wisconsin (SNOW) scale, a simple 3-item/element tool derived from the NIHSS.[24] SNOW includes speaking difficulty/expressive aphasia, neglect and ocular/gaze deviation. The presence of any one of these findings is considered positive for LVO. It does not require scoring, nor does it require motor testing or testing for visual field, diplopia, and ocular alignment (as VAN does). Additionally, the SNOW scale was found to have high accuracy and sensitivity in both retrospective and prospective validation trials.[23-25]

The aim of this study was to prospectively evaluate the performance of the SNOW scale in predicting LVO and need for EVT in the prehospital setting. Any additional data predictive of patients presenting with DMVO would be an added benefit. In Milwaukee County, 3 hospital systems have an ECSC. Milwaukee County Emergency Medical Services (EMS) led a collaborative effort to incorporate the "Mission: Lifeline Algorithm" into its stroke triage protocol using the SNOW scale for determination of probable LVO, and the efficacy of SNOW in this regard was evaluated prospectively over a 12-month period. Herein, we report the performance of SNOW for predicting LVO and DMVO, as well as EVT candidacy, in patients transported to 1 of the 3 ECSCs in Milwaukee County, Aurora St. Luke's Medical Center (ASLMC).

METHODS

Study Setting

Milwaukee County is the most populous county in Wisconsin, serving an estimated population of 948,201 in 2018. There are 3 ECSCs and 10 primary stroke centers in the county, with an average travel time between primary stroke center and ECSC of ~4 minutes.

Study Protocol and EMS Training

Prior to implementing the new AIS triage algorithm, all EMS personnel in Milwaukee County completed video-based education. The provided video described the components of the SNOW scale, demonstrated the application of SNOW, and informed transport decision-making (detailed visual available at https://county.milwaukee.gov/files/county/emergency-management/EMS-/Standards-of-Care/2020PGStroke061520.pdf). EMS personnel are to assess a patient first for universal care, then screened for stroke by BEFAST (ie, Balance, Eyes, Face, Arm, Speech, Terrible headache).[26] If a patient is BEFAST-positive, they are assessed for LVO/DMVO per SNOW (ie, Speaking difficulty, Neglect, and Ocular deviation) in order to make transport decisions. All EMS personnel undergo continuing education on all standards of care, including SNOW (https://county.milwaukee.gov/EN/Office-of-Emergency-Management/EMS/Standards-of-Care). EMS personnel also have access to an app that has all of the standard of care information readily available.

The new triage algorithm was implemented on March 1, 2018. Upon initial contact with the patient, EMS personnel screened all suspected stroke patients for the 5 BEFAST stroke signs: loss of Balance (or dizziness), Eyes (vision loss or double vision), Facial droop, Arm drift, Speech abnormality, and "Terrible" headache.[27] BEFAST was considered positive if at least one element was determined to be abnormal. Patients with a positive BEFAST were subsequently assessed for LVO and DMVO using the SNOW scale (Figure 1, red shading).[27,28]

Table 1. Comparison of Stroke Prediction Tools/Scales per Literature Review

Tool/Scale	Year published	Makeup	Items (points)	Sev stroke	Mod stroke	ID of LVO*	Additional reliability	Additional notes
NIHSS	1994	11 items, 10-point scale		score of ≥10	score of ≥6			-Standard of care -Commonly used in statewide EMS protocols
Sensitivity				0.64	0.76			
Specificity				0.85	0.70			
PPV				0.68	0.55			
NPV				0.83	0.85			
Accuracy				0.78	0.72			
LAMS	2001	3 items, 5-point scale	Facial droop (0/1); arm drift (0/1/2); grip strength (0/1/2)			score of ≥4	Completion time: rank 4 of 7 LR+: 3.5; LR-: 0.51	-Prehospital tested with external data sets -Official scale used in Rhode Island EMS
Sensitivity						0.38		
Specificity						0.93		
PPV						0.28		
NPV						0.95		
Accuracy						0.89		
RACE	2014	6 items, 9-point scale	Facial palsy (0/1/2); arm motor function (0/1/2); leg motor function (0/1/2); head & gaze deviation (0/1) Based on side: right aphasia (0/1/2); left aphasia (0/1/2)	score of ≥5		score of ≥5	Completion time: rank 7 of 7 LR+: 4.17; LR-: 0.48	-Prehospital tested with external data sets
Sensitivity				0.55		0.56		
Specificity				0.87		0.90		
PPV				0.68		0.32		
NPV				0.79		0.96		
Accuracy				0.77		0.88		
C-STAT	2015	3 items, 5-point scale	Gaze (0/2); arm weakness (0/1); consciousness (0/1)			score of ≥2	Completion time: rank 5 of 7 LR+: 4.09; LR-: 0.48	-Prehospital tested with external data sets -Fails to recognize the importance of cortical signs
Sensitivity				0.77	0.64	0.62		
Specificity				0.84	0.91	0.80		
PPV						0.21		
NPV						0.96		
Accuracy						0.79		
AUC				0.89	0.90			
FAST-ED	2016	5 items, 9-point scale	Facial palsy (0/1); arm weakness (0/1/2); speech changes (0/1/2); eye deviation (0/1/2); denial/neglect (0/1/2)			score of ≥4	NT	-Prehospital tested with external data sets -Easy to learn and remember as EMS already are familiar with FAST
Sensitivity						0.60		
Specificity						0.85		
PPV						0.25		
NPV						0.96		
Accuracy						0.83		
VAN	2016	4 items	Must have: Weakness of arms *and one of* Visual field, Aphasia, or Neglect				Completion time: rank 2 of 7	-No prehospital data -Conducted by nurses following hospital arrival
Sensitivity				1.0		0.81		
Specificity				0.9		0.38		
PPV				0.74		NT		
NPV				1.0		NT		

Table continued on next page

Table 1 (cont). Comparison of Stroke Prediction Tools/Scales per Literature Review

Tool/Scale	Year published	Makeup	Items (points)	Sev stroke	Mod stroke	ID of LVO*	Additional reliability	Additional notes
PASS	2017	3 items, 3-point scale	Level of consciousness (0/1); gaze palsy/ deviation (0/1); arm weakness (0/1)			score of ≥2	Completion time: rank 1 of 7 LR+: 3.84; LR-: 0.47	-Prehospital tested, no external data sets -Scores similar to or better than LAMS and RACE in detecting LVO
Sensitivity						0.55		
Specificity						0.83		
PPV						0.21		
NPV						0.95		
Accuracy				0.81		0.81		
G-FAST	2017	5 items	Gaze, best; Facial palsy; Arm weakness; Speech changes; Time			score of ≥3	NT	
Sensitivity						0.61		
Specificity						0.84		
PPV						0.24		
NPV						0.96		
Accuracy						0.82		

**As scored by Nguyen et al (2021),[22] except for VAN scale, which was scored by Teleb et al (2017).[18]*

C-STAT, Cincinnati Stroke Triage Assessment Tool; EMS, emergency medical services; FAST-ED, Facial palsy, Arm weakness, Speech changes, Time, Eye deviation, Denial/neglect scale; G-FAST, Gaze, Face, Arm, Speech, Time scale; ID, identification; LAMS, Los Angeles Motor Scale (derived from components of Los Angeles Prehospital Stroke Screen); LR-, negative likelihood ratio; LR+, positive likelihood ratio; LVO, large vessel occlusion; Mod, moderate; NIHSS, National Institutes of Health Stroke Scale; NPV, negative predictive value; NT, not tested; PASS, Prehospital Acute Stroke Scale; PPV, positive predictive value; RACE, Rapid Arterial Occlusion Evaluation scale; Sev, severe; VAN, Vision, Aphasia, Neglect screening.

All patients with a last-known-well time of less than 24 hours, who were positive for a stroke using BEFAST, and who were SNOW scale-positive were determined to be at risk for an LVO and were directly transported to the nearest (or the patient's preferred) ECSC, provided that transport did not add more than 15 minutes to the total transport time. Patients with a positive BEFAST but a negative SNOW scale were transported to the closest acute stroke-ready hospital. Exceptions were: 1) patients with unstable vital signs; 2) patients in hospice; or 3) patients with baseline severe dementia. Patients meeting these criteria were transported to the closest stroke hospital (https://county.milwaukee.gov/files/county/emergency-management/EMS-/Standards-of-Care/2020PGStroke061520.pdf).

Upon arrival at ASLMC, the patient was reassessed for NIHSS score and acute stroke code activation. Based on the presence of cortical signs or high NIHSS scoring, the on-call stroke neurologist determined whether computed tomographic (CT) angiography with/without CT perfusion imaging was indicated. Similarly, for an LVO, the on-call neurointerventionalist would make the decision whether or not to perform EVT based on the location and size of the clot and time following infarct. In patients diagnosed with DMVO, EVT was performed for occlusions in M2, A1, and P1. For more distal DMVO (M3/M4, A2–A5, P2–P5), severity of the stroke was used to determine EVT eligibility.

Data Abstraction

This study was approved by the ASLMC institutional review board and deemed not to necessitate human subjects research approval. Data for this study spanned the period from March 1, 2018, to end of February 2019. Milwaukee County EMS data included BEFAST and SNOW outcomes (including LVO positivity per SNOW; for a detailed visual of criteria, see https://county.milwaukee.gov/files/county/emergency-management/EMS-/Standards-of-Care/2020TOOLLVO061520.pdf). ASLMC patient data included demographic characteristics, final discharge diagnosis, imaging data, and thrombectomy data. LVO was confirmed using CT, magnetic resonance, or cerebral angiogram. LVO was defined as terminal internal carotid artery, middle cerebral artery (M1), or basilar artery occlusion.

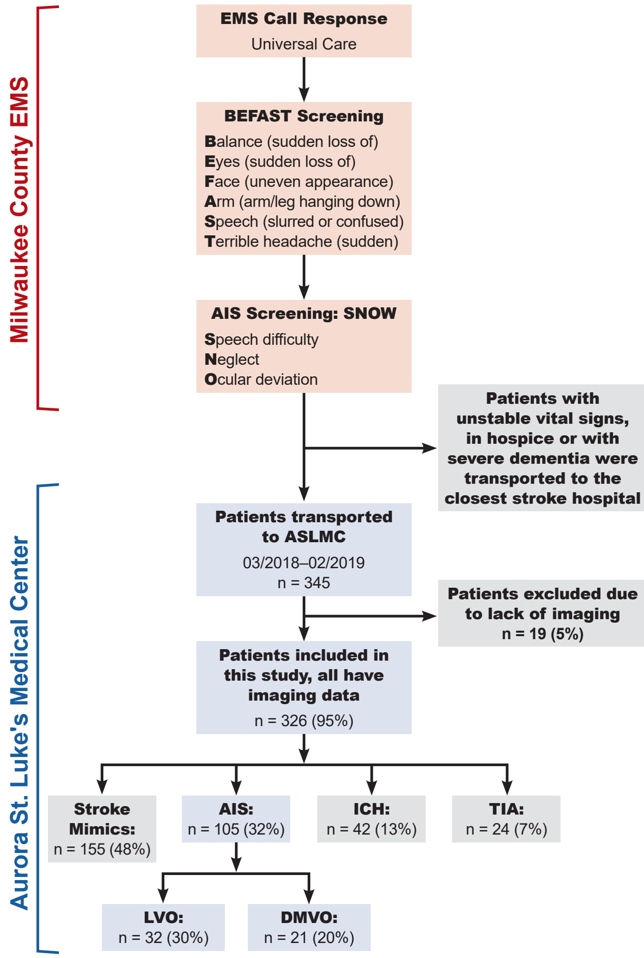

Figure 1. *Flow chart outline of study. The role of the Milwaukee County Emergency Medical Services (EMS) in the initial patient interaction is shaded in red, while the portion of the study conducted at Aurora St. Luke's Medical Center (ASLMC) is shaded blue. Patients who are not included in the analysis of large vessel occlusion (LVO) or distal medium vessel occlusion (DMVO) are shaded in gray. AIS, acute ischemic stroke; ICH, intracerebral hemorrhage; SNOW, Stroke Network of Wisconsin scale; TIA, transient ischemic attack.*

DMVO were those which included occlusion of a segment of the anterior cerebral artery (A1–A5), middle cerebral artery (M2–M4), posterior cerebral artery (P1–P5), superior cerebellar artery, anterior inferior cerebellar artery, or posterior inferior cerebellar artery.[10]

Patients with AIS without vascular imaging (n=19) were excluded from the SNOW performance analysis (Figure 1). Patients with a final diagnosis of transient ischemic attack, intracerebral hemorrhage, stroke mimic, or AIS without LVO were classified as having "no LVO."

Table 2. Baseline Patient Characteristics (N=326)

Characteristics	n (%)
Mean age ± SD	73.89 ± 14.58 years
Sex, female	188 (58%)
Diagnosis	
Acute ischemic stroke	105 (32%)
Stroke mimics	155 (48%)
Intracerebral hemorrhage	42 (13%)
Transient ischemic attack	24 (7%)
Large vessel occlusion	n=32
Intracranial ICA	7 (22%)
M1	25 (78%)
Distal medium vessel occlusion	n=21
M2	16 (76%)
M3	3 (14%)
A2	1 (5%)
P2	1 (5%)
Intravenous alteplase	41 (39%)*
Mechanical thrombectomy	24 (22.3%)

**5 of these had stroke mimics.*

A2, anterior cerebral artery segment; ICA, internal carotid artery; M1–M3, middle cerebral artery segments; P2, posterior cerebral artery segment; SD, standard deviation.

Outcome Measurements

The primary outcome measure was presence or absence of LVO with the secondary outcome measure as patients warranting EVT intervention. As per American Heart Association guidelines,[29] patients who were EVT candidates had a prestroke modified Rankin score of 0–1, presented with a causative occlusion of the internal carotid artery or M1, were ≥18 years of age, exhibited an NIHSS score of ≥6, and had ASPECTS of ≥6. Also, patients are only candidates for EVT if treatment can be initiated within 6 hours of symptom onset.

Statistical Analysis

All statistical analyses were performed using SAS® 9.4 software (SAS Institute Inc,). Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for LVO detection and thrombectomy were calculated with 95% CI. The receiver operating characteristic curve was graphed and area under the curve (AUC) calculated to assess SNOW scale accuracy.

RESULTS

Time to reperfusion following stroke is inversely associated with clinical benefit, therefore the ability to predict risk of an LVO or DMVO in the prehospital

Table 3. SNOW Prediction Screening Tool Specifications

Tool/Scale	Year published	Makeup	Items (positive/negative)	ID of LVO
SNOW	2018	3 items; + if present	Speech (+/-); Neglect (+/-); Ocular deviation (+/-)	positive for any 1 item
Sensitivity				0.88
Specificity				0.40
PPV				0.14
NPV				0.97
AUC				0.64
True negative				118
False negative				4
True positive				28
False positive				176

AUC, area under the curve; ID, identification; NPV, negative predictive value; PPV, positive predictive value; LVO, large vessel occlusion; SNOW, Stroke Network of Wisconsin scale.

setting is critical. In order to test the predictive value of the SNOW scale, Milwaukee County EMS used the SNOW prediction tool (https://county.milwaukee.gov/files/county/emergency-management/EMS-/Standards-of-Care/2020TOOLLVO061520.pdf) when responding to a call to determine whether the patient required transfer to an ECSC. A positive score on any of the 3 SNOW items was taken as an indication of LVO (or DMVO). SNOW scale results informed the decision to transport the patient to either a primary stroke center (non-LVO status) or to 1 of the 3 ECSCs (LVO status) within Milwaukee County: ASLMC (setting for the current study), Froedtert Hospital, or Ascension St. Mary's Milwaukee. During the study period, ASLMC received 345 patients with suspected stroke. Of these 345, 19 patients were excluded from the SNOW scale performance analysis due to a lack of vascular imaging (Figure 1).

Of the remaining 326 patients, diagnosis of AIS was determined in 105 (32%), intracranial hemorrhage in 42 (12%), transient ischemic attack in 24 (7%), and stroke mimics in 155 (45%) (Figure 1, Table 2). The mean age of the analyzed patients was 73.89 ± 14.58 years, and 58% were female. LVO was confirmed in 30% (32 of 105) of the patients with AIS. Of these, 7 had internal carotid artery occlusion and 25 had M1 middle cerebral artery occlusion. DMVO was confirmed in 21 patients, of whom 16 had M2 branch occlusion, 3 had M3 occlusion, 1 had A2 occlusion, and 1 had P2 occlusion. In all, 41 of the patients with AIS received intravenous alteplase while 24 underwent mechanical thrombectomy.

Of the 326 patients analyzed, 204 were identified by Milwaukee County EMS as SNOW-positive and 122 as SNOW-negative. Using SNOW scale scoring, Milwaukee County EMS correctly identified 28 of 32 patients (true positives) who had an LVO, a sensitivity of 0.88 and a specificity of 0.40. Thus, use of the SNOW scale by Milwaukee County EMS correctly identified 87.5% of LVOs. The scale's PPV was 0.14, the NPV was 0.97, and the AUC was 0.64 (Table 3). In short, SNOW-positive patients are significantly more likely to have LVO than SNOW-negative patients (odds ratio: 4.69, 95% CI: 1.60–13.73), pointing toward a greater utility of SNOW for identifying patients who would not require an EVT-capable facility.

Of the 21 patients who were found to have a DMVO, the Milwaukee County EMS identified 15 as SNOW-positive, for a sensitivity of 0.71, specificity of 0.38, PPV of 0.07, NPV of 0.95, and AUC of 0.51. Therefore, of the 53 patients diagnosed with either a LVO or DMVO, SNOW scoring by Milwaukee County EMS correctly identified 43 of them, resulting in overall sensitivity of 0.81, specificity of 0.41, PPV of 0.22, NPV of 0.92, and AUC of 0.56. When analyzing how well a positive SNOW score predicted thrombectomy at ASLMC, sensitivity was 0.83, specificity 0.39, PPV 0.10, NPV 0.97, and AUC 0.53.

DISCUSSION

In this study of the ability of the SNOW scale to predict, in the prehospital setting, which patients require transport to an ECSC, SNOW demonstrated a high sensitivity (88%) and a low specificity (40%) to detect LVO. Ability to correctly identify patients who may require advanced stroke care is vital, but SNOW also differentiated those patients who would not require EVT treatment. The application of SNOW by Milwaukee County EMS correctly identified 87.5% of patients with LVO. Among patients who were presumed to have AIS, the odds of having either LVO or DMVO when SNOW was positive were significantly greater than when SNOW was negative. Taken together, this means that when the SNOW score is negative, LVO or DMVO are unlikely, an important aspect for community- and also value-based care.

Our previous in-hospital-based studies demonstrated sensitivities of 80% and 84% and specificities of 76% and 63% in SNOW's ability to predict LVO in patients with AIS.[23,24] While the sensitivity remained consistently high for this prehospital application of the SNOW tool, the reduced specificity seen in this analysis is likely due to the composition of the study population (patients with AIS represented 36% of this study cohort vs 100% of the inpatient cohorts) and the increased experience of in-hospital stroke teams conducting the SNOW examination as compared to Milwaukee County EMS personnel.

SNOW scale predicted either a LVO or DMVO with equal sensitivity. DMVO accounts for 25%–40% of all AIS cases, and current evidence shows that one-half to two-thirds of DMVO patients achieve recanalization after intravenous alteplase treatment, with most patients incurring a lasting functional disability.[7-10] Therefore, a screening tool scale that looks beyond LVO to include DMVO in the prehospital setting makes sense.

In addition to LVO, the SNOW scale also predicted candidates for EVT regardless of occlusion type. A positive SNOW detected 83% of patients who subsequently underwent EVT, which is higher than RACE, the next closest prediction scale, for which cutoffs were reported to be 77% and 75% (for a score ≥5).[30]

At this moment, no prehospital stroke prediction scale has both high sensitivity and specificity in detecting LVO. Nguyen et al[22] conducted head-to-head performance and feasibility comparisons of 7 LVO prediction scales — C-STAT, G-FAST, FAST-ED, LAMS, PASS, RACE, and the gaze, facial asymmetry, level of consciousness, extinction/inattention (GACE) scale — in the prehospital setting and demonstrated that all scales had good accuracy (0.79–0.89). RACE and LAMS had the highest accuracy as well as high specificity (0.80–0.93) but low sensitivity (0.38–0.62) (Table 1, ID of LVO column). RACE had the lowest feasibility rate. Interestingly, the VAN scale was not evaluated in the study at all.[22] Crowe et al retrospectively studied prehospital electronic patient records from 151 EMS agencies with documented LVO scales (CPSS, RACE, LAMS, or VAN) and found no statistically significant difference in identifying LVO among these scales.[31] Prehospital LVO prediction studies conducted using the RACE, C-STAT, LAMS, FAST-ED, and VAN scales demonstrated sensitivity and specificity, respectively, of 84% and 60% for RACE, 84% and 60% for C-STAT, 76% and 65% for LAMS, 63% and 70% for FAST-ED, and 81% and 38% for VAN.[16,32-36] Although no head-to-head comparison has been made, inference of the SNOW scale shows a very high sensitivity (similar to RACE, perhaps[32]) but low specificity (akin to the VAN scale[36]).Of additional relevance, SNOW is the simplest scale available, with only 3 items to check.

The optimal prehospital triage strategy for each community will vary and depend on the distance between primary stroke center and ECSC, in-hospital performance metrics, and local policies.[37] An ideal scale in any geographic area is one that is easy to learn and simple to conduct and does not require either lengthy training or periodic maintenance.[31] Interestingly, even with brief and informal training on the SNOW scale, Milwaukee County EMS did very well. Since it could be difficult to differentiate aphasia from dysarthria and check for neglect by EMS providers, Milwaukee County EMS went a step further and created the SNOW scale instruction sheet (available at https://county.milwaukee.gov/files/county/emergency-management/EMS-/Standards-of-Care/2020TOOLLVO061520.pdf), which has been in use since the end of the present study in 2019.

Limitations

This study has several limitations. First, it only included data from a single center, as we did not have access to data from the other two ECSCs in Milwaukee County. In addition, despite receiving training, we cannot guarantee that all EMS personnel were 100% proficient in the BEFAST or SNOW scales. The number of patients and, specifically, the number of patients who were determined to have an LVO, was small. Additionally, 18% of patients with AIS did not have vascular imaging completed and were therefore excluded from the analysis. Finally, our cohort did not include basilar artery occlusion and thus we don't know how predictive the SNOW scale is for posterior circulation events.

CONCLUSIONS

Following implementation instruction to emergency medical services personnel, the Stroke Network of Wisconsin (SNOW) screening tool proved reasonably accurate in predicting large vessel occlusion in patients suspected of acute ischemic stroke prior to arrival at the hospital. The SNOW scale is the simplest of the validated stroke prediction scales and is also easy to learn and implement in the prehospital setting. If a patient presumed to have a stroke has a negative SNOW score, LVO is unlikely, while the odds of LVO is significantly greater with a positive SNOW score. The utility of SNOW for prehospital triage would increase if identification of acute ischemic versus other types of stroke can be further refined.

Patient-Friendly Recap

- The ability of community-based emergency care providers (EMS) to accurately identify stroke type en route to a medical facility is especially important as it applies to effective treatment of large vessel occlusion (LVO).
- The Stroke Network of Wisconsin (SNOW) screening tool for LVO — previously validated in a hospital setting — was implemented by Milwaukee County EMS and studied for its potential in triaging patients with suspected stroke to the most appropriate medical facility.
- EMS correctly flagged 43 of 53 patients with later-confirmed LVO or distal medium vessel occlusion and were able to consistently rule out LVO from their prehospital assessment.
- The SNOW scale showed high sensitivity but low specificity in predicting candidates for endovascular thrombectomy, a time-sensitive treatment.

Author Contributions

Study design: Panichpisal, Rovin. Data acquisition or analysis: Erpenbeck, Vilar, Babygirija, Singh, Colella. Manuscript drafting: Panichpisal. Critical revision: Rovin.

Conflicts of Interest

None.

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