Incorporating Diffusion-Weighted Magnetic Resonance Imaging into an Observation Unit Transient Ischemic Attack Pathway: A Prospective Study

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J. Adam Oostema, MD¹, Mark DeLano, MD², Archit Bhatt, MD³,
and Michael D. Brown, MD⁴

Abstract

Background and Purpose: National guidelines advocate for early, aggressive transient ischemic attack (TIA) evaluations and recommend diffusion-weighted magnetic resonance imaging (MRI) for brain imaging. The purpose of this study is to examine clinician compliance, the yield of MRI, and patient-centered clinical outcomes following implementation of an emergency department observation unit (EDOU) clinical pathway incorporating routine MRI into the acute evaluation of patients with TIA. **Methods:** This is a prospective observational study of patients with TIA admitted from the ED. Patients with low-risk TIA were transferred to an EDOU for diagnostic testing including MRI; high-risk patients were directed to hospital admission. Clinical variables, diagnostic tests, and treatment were recorded for all patients. The primary clinical outcome was the rate of stroke or recurrent TIA, determined through telephone follow-up and medical record review at 7 and 30 days. **Results:** A total of 116 patients with TIA were enrolled. In all, 92 (79.3%) patients were transferred to the EDOU, of whom 69 (59.5%) were discharged without hospitalization. Compliance with the EDOU pathway was 83 (91.2%) of 92. Magnetic resonance imaging demonstrated acute infarct in 16 (15.7%) of 102 patients. Stroke ($n = 2$) or TIA ($n = 3$) occurred in 5 patients with TIA (4.3%, 95% confidence interval: 1.6%-10.0%) within 30 days; no strokes occurred after discharge. **Conclusion:** Implementation of a TIA clinical pathway incorporating MRI effectively encouraged guideline-compliant diagnostic testing; however, patient-important outcomes appear similar to diagnostic protocols without routine MRI. Further study is needed to assess the benefits and costs associated with routinely incorporating MRI into TIA evaluation.

Keywords

outcomes, techniques, imaging, techniques, ischemic attack, transient, cerebrovascular disorders, stroke and cerebrovascular disease, clinical specialty

Introduction

Patients who present to the emergency department (ED) with a transient neurological deficit are known to be at high risk of recurrent transient ischemic attack (TIA) and stroke both short and long term.¹⁻³ Early identification of risk factors for recurrent stroke and aggressive secondary prevention measures have been shown to improve patient outcomes^{4,5} and this strategy is supported by national guidelines.^{6,7} Nevertheless, the extent, the timing, and the preferred setting for this evaluation remain unclear, resulting in wide variations in clinical practice.^{8,9}

Since most patients with TIA do not ultimately experience a stroke, risk stratification is essential to determining the appropriate disposition for an ED patient with TIA symptoms. Although clinical decision rules such as the ABCD² score correlates with stroke risk,^{10,11} questions remain as to whether or

not they can effectively identify very low-risk populations appropriate for discharge¹²⁻¹⁴ or obviate the need for urgent

¹ Department of Emergency Medicine, Spectrum Health, Michigan State University College of Human Medicine, Grand Rapids, MI, USA

² Department of Radiology, Spectrum Health, Michigan State University College of Human Medicine, Grand Rapids, MI, USA

³ Providence Stroke Center, Providence Brain and Spine Institute, Portland, OR, USA

⁴ Department of Emergency Medicine, Spectrum Health, Michigan State University College of Human Medicine, Grand Rapids, MI, USA

Corresponding Author:

J. Adam Oostema, Department of Emergency Medicine, Michigan State University College of Human Medicine, Secchia Center, Room 425, 15 Michigan, NE, Grand Rapids, MI 49503, USA.
Email: oostema@msu.edu

testing.^{15,16} This is of particular concern in clinical settings where urgent neurology follow-up or access to primary care is not available. Furthermore, multiple studies have documented that patients with TIA who have evidence of infarct on magnetic resonance imaging (MRI) are at substantially increased risk of stroke,¹⁷⁻²² and incorporation of MRI findings into the risk stratification process substantially improves prognostication.²³ As a result, national guidelines now recommend MRI as the “preferred” brain imaging modality over noncontrast computed tomography (CT).⁶ However, less than 40% of EDs have 24/7 access to this technology.²⁴

Emergency department observation units (EDOUs) have been previously shown to be an effective and efficient setting for the completion of TIA workups.²⁵⁻²⁷ In order to support the provision of guideline-compliant TIA care in our ED and optimize risk stratification, we developed and implemented a TIA clinical pathway to achieve a TIA workup routinely including MRI in an ED OU. The purpose of this descriptive study was to evaluate the effectiveness of the pathway by assessing clinician compliance with national recommendations, measuring the marginal yield of MRI when routinely incorporated into the evaluation of patients with TIA, and describing patient-centered clinical outcomes.

Methods

Setting

The study was conducted at 2 large urban community hospitals affiliated to a medical school and emergency medicine residency program. The hospitals are certified Primary Stroke Centers with 24-hour MRI availability. The ED volume exceeds 130 000 adult patient visits annually. This study was approved by the institutional review board, and informed consent obtained from all participants.

Selection of Participants

Patients undergoing an ED workup for suspected TIA were eligible for inclusion in this prospective cohort study. Patients were identified through e-mail notifications to study staff whenever the electronic TIA order set was initiated in the ED. Patients were then enrolled by research assistants in the ED, ED OU, or hospital within 24 hours of ED evaluation. In order to obtain a consecutive sample, patients discharged prior to enrollment were contacted by telephone to obtain consent for chart review and follow-up telephone call. Patients were excluded only if they declined consent, were discharged directly from the ED, or were determined to have a definitive non-TIA diagnosis.

Transient Ischemic Attack Clinical Pathway

The ED TIA clinical pathway (supplemental figure) was developed with input from ED physicians, a neurologist, neuroradiologist, a representative of the hospital quality

department, and a representative of a major health insurance carrier using the 2009 ASA Scientific Statement for guidance.⁶ The pathway was designed to expedite the acquisition of recommended diagnostic tests and facilitate discharge of patients with negative evaluations.

Following a standard history and physical, patients had basic laboratory studies (blood count and chemistry panel) and electrocardiogram (ECG) performed in the ED. Patients with TIA were required to be asymptomatic prior to transfer to the ED OU without CT brain imaging. Patients with clear high-risk features such as persistent deficits, crescendo TIA, or atrial fibrillation requiring anticoagulation were admitted to the hospital and their care was managed by the hospitalist team; the TIA clinical pathway was not utilized to guide inpatient care. In the ED OU, patients received serial neurological checks by nursing staff, cardiac monitoring for atrial fibrillation, and diagnostic imaging studies. Imaging was directed by the clinical pathway and preferentially directed patients toward brain MRI with diffusion-weighted imaging (DWI). Echocardiography and neurology consultation were obtained at the discretion of the ED OU attending physician.

Patients in the ED OU who were found to have acute infarction on DWI, atrial fibrillation not previously recognized, clinically significant carotid stenosis, or neurological deterioration were deemed high risk and admitted to the hospital. Those with negative evaluations were discharged on antiplatelet therapy and instructed to follow-up with their primary care provider.

Imaging

All brain MR examinations were performed at 3 T (GE Healthcare, Waukesha, Wisconsin) and included standard with T1, T2, FLAIR, gradient echo, and diffusion-weighted sequences, and postcontrast T1-weighted brain imaging after MR angiography of the neck. Diffusion imaging was performed with 4-mm slice thickness, in-plane resolution of 1.8 mm × 1.9 mm, a diffusion b value of 1000 s/mm², and 1 signal average. Contrast used for MR angiography and axial T1-weighted brain imaging was 20 mL gadobenate dimeglumine (MultiHance; Bracco Diagnostics, Milan, Italy). Time from presentation to completion of imaging was less than 24 hours in all patients (mean 14.5 hours).

Data Collection

Patient enrollment began about 3 months after the pathway was initiated. A standardized data collection form was used to abstract clinical data and diagnostic study results. Clinical variables such as the ABCD² score were either collected at the time of enrollment or from the medical record review. The results of radiographic studies were abstracted from the radiology department's written reports. Clinical outcomes were determined by telephone follow-up at 30 days using a standardized instrument to inquire about recurrent symptoms, doctor

visits, hospitalizations, and further treatments initiated since discharge. Medical records were also reviewed for all patients.

Data Analysis

Final diagnosis and clinical outcomes were verified by 2 of the investigators, an ED physician (JAO) and a stroke neurologist (AB); this was accomplished by having each conduct an independent detailed review of the ED, EDOU, and inpatient medical records. Transient ischemic attack was defined as a sudden onset of focal neurological deficit that resolved within 24 hours and was not explained by a clear nonvascular diagnosis.²⁸ Stroke was defined as a sudden, focal neurological deficit resulting from cerebral ischemia and persisting longer than 24 hours.

Descriptive statistics were used to characterize the study population in terms of stroke risk factors and medical comorbidities. The proportion of participants who received relevant diagnostic studies and the yield of those studies were calculated. Interpretation of imaging studies was based on review of the final radiologist or cardiologist's written report. Studies were considered positive if brain imaging identified acute or subacute cerebral infarction, carotid imaging identified stenosis over 50% or cervical vessel dissection, or echocardiography identified a potential cardioembolic source (thrombus, valvular vegetation, ventricular aneurysm, patent foramen ovale [PFO], atrial septal defect, mechanical valve, or severely depressed ejection fraction). Atrial fibrillation was diagnosed if identified by ECG or telemetry monitoring in the EDOU or inpatient setting. Chi-square tests were used to compare the rate of diagnostic testing among EDOU and inpatient groups for each category of test (brain imaging, cervical vessel imaging, telemetry, and echocardiography) and neurology consultation.

For those patients with a final diagnosis of TIA, we calculated compliance with 3 class I national guideline recommendations: (1) brain imaging within 24 hours of presentation, (2) cervical vessel imaging, and (3) discharge on antiplatelet medication or systemic anticoagulation.^{6,7} The marginal yield of MRI was calculated as the number of patients with TIA having acute infarct on DW MRI in the absence of other identified cervical vessel or cardiac pathology divided by all patients with MRI. The primary clinical outcome was the combined rate of incident ischemic stroke or recurrent TIA within 7 and 30 days of initial evaluation. A chi-square test was used to compare the rate of stroke at 7 days among enrolled patients to the rate of stroke predicted by ABCD² score.¹⁰

Results

Over an 18-month period (June 2010 to December 2011), 133 patients consented to participate (Figure 1). In all, 2 patients subsequently withdrew consent, 6 had definitive non-TIA diagnoses, and 9 were discharged from the ED, leaving 116 patients with TIA. Interrater agreement for TIA diagnosis was 92.4% ($\kappa = .46$). Nearly 80% (92 of 116) of patients with TIA were placed into the EDOU pathway. Of these patients, 69

(75% of EDOU cases and 59.6% of all patients with TIA) were discharged without hospital admission. Of the patients that ultimately had a negative evaluation, those discharged from the EDOU had a shorter length of stay (18.8 hours) than those discharged from the hospital (40.8 hours).

Clinical characteristics of study participants are summarized in Table 1. Medical records were reviewed for all 116 patients at 30 days. Eighty-five (73.3%) patients were reached for telephone follow-up, and all had review of the electronic medical record. Formal neurology consultation was obtained in 43 (37.1%) patients, more frequently among admitted patients than those in the EDOU (66.7% vs 29.3%, $P < .05$).

Guideline Compliance

The performance of diagnostic tests is reported in Table 2. The clinical pathway was used as guidance for the care of EDOU patients but those directly admitted were managed at the discretion of the hospitalist service. Compliance with all 3 recommendations (brain imaging, cervical vessel imaging, and antiplatelet/anticoagulant prescribing) was 102 of 116 (87.9%, 95% confidence interval [CI]: 80.6-92.8%) and was higher among EDOU patients (91.2%) than those directly admitted (79.2%).

All 116 patients received brain imaging (100%, 95% CI: 96.1-100%) with 102 (87.9%) receiving MRI, 50 (43.1%) receiving CT, and 34 (29.3%) receiving both. Emergency department observation unit patients received MRI more frequently than those directly admitted from the ED (94.6% vs 62.5%) and received duplicate brain imaging less often (25.0% vs 45.8%). Carotid imaging was obtained for 110 patients (94.8%, 95% CI: 88.9-97.8%), more frequently in the EDOU (97.8% vs 83.3%, $P < .05$). Patients were discharged with antiplatelet therapy or on anticoagulation in 108 (93.1%, 95% CI: 86.8-96.7%) patients. Compliance with recommended discharge medications was similar for EDOU and admitted patients.

Yield of Diagnostic Testing

The acquisition and yield of diagnostic tests are reported in Table 2. Overall, 71 patients (61.2%, 95% CI: 52.1-69.6%) had a negative evaluation on all of their diagnostic tests.

Brain Imaging

Acute infarction was identified in 17 of the 116 included patients (14.7%, 95% CI: 9.3-22.3%); 16 patients were identified by DW MRI and 1 by CT. Of the 16 positive MRI patients, 7 occurred among patients with an otherwise negative diagnostic workup (7 of the 102, 6.9%, 95% CI: 3.1-13.7%). None of these individuals had a subsequent adverse event.

Figure 1. Distribution of patients based on ED disposition. The ED physician determined appropriate disposition based on clinical evaluation, informed by the clinical pathway. Patients who had nonfocal symptoms (eg, dizziness or altered mental status) or high-risk features (eg, crescendo symptoms or atrial fibrillation with subtherapeutic international normalized ratio [INR]) were not candidates for the Emergency Department Observation Unit (EDOU). ED indicates Emergency Department.

Cervical Vessel Imaging

Of the 110 carotid imaging studies, 20 (17.2%, 95% CI: 11.3-25.2%) were positive: 18 (16.4%) identified carotid stenosis greater than 50% and 2 (1.8%) identified vertebral artery dissection. Six patients underwent carotid intervention.

Electrocardiogram/Telemetry

Seven patients (6.0%, 95% CI: 2.7-12.1%) had observed episodes of atrial fibrillation, 5 of which occurred in patients with a history of atrial fibrillation. Two (1.7%) new cases were identified: one on the presenting ECG in the ED and one on telemetry monitoring in the observation unit (OU).

Echocardiography

Echocardiography was obtained for 63 (54.3%) of the 116 patients (57 transthoracic and 6 transesophageal). A potential cardioembolic source was demonstrated in 15 studies (23.1%, 95% CI: 14.4-34.8%), most often a PFO (12 of 15). Although the pathway did not prescribe criteria for acquisition of echocardiogram, it was obtained more often among MRI-positive

patients (81.3%) than MRI-negative patients (53.3%). Acute infarct on MRI was not associated with a higher rate of cardioembolic source detection.

Clinical Outcomes

Of the 116 patients with TIA, 5 (4.3%, 95% CI: 1.6-10.0%) experienced the primary clinical end point of stroke ($n = 2$) or recurrent TIA ($n = 3$) within 30 days (see Table 3). Both strokes (1.8%, 95% CI: 0.1-6.5%) occurred in the hospital within 48 hours of initial ED presentation. One (0.9%) patient died of nonvascular causes within 30 days of presentation.

The observed stroke rate was lower than predicted by ABCD² score at 7 days, but the difference did not reach statistical significance (1.8% vs 4.8% predicted by ABCD², $P = .12$). None of the 22 patients with an ABCD² score <3 experienced a stroke, but 7 (31.8%) had positive findings during the course of their evaluation (supplemental figure). The risk of subsequent stroke over 30 days was higher among DWI-positive patients (1 of 16, 6.3%) as compared to DWI negative (1 of 86, 1.2%).

Table 1. Baseline Characteristics of Included Patients.

	All Patients (n = 116)	EDOU (n = 92)	Inpatient (n = 24)
Demographics			
Mean age (SD)	65.3 (15.6)	64.9 (16.2)	66.8 (12.7)
Female	60 (51.7)	49 (53.3)	11 (48.5)
White	107 (92.2)	84 (91.3)	23 (95.8)
Black	5 (4.3)	5 (5.4)	0
Hispanic/Latino	1 (0.9)	1 (1.1)	0
Risk factors/medical history			
Median ABCD ² (IQ range)	4 (3 to 5)	4 (3 to 5)	4.5 (3 to 5)
HTN	74 (63.8)	57 (62.0)	17 (70.8)
Dyslipidemia	58 (50.0)	41 (44.6)	17 (70.8)
Diabetes	28 (24.1)	22 (23.9)	6 (25.0)
Prior stroke/TIA	26 (22.4)	17 (18.5)	9 (37.5)
Current smoking	20 (17.2)	16 (17.1)	4 (16.7)
CAD	18 (15.5)	13 (14.1)	5 (20.8)
A fib	14 (12.1)	9 (9.8)	5 (20.8)
Migraines	13 (11.2)	9 (9.8)	4 (16.7)
PVD	10 (8.6)	6 (6.5)	4 (16.7)
Seizure	4 (3.4)	2 (2.2)	2 (8.3)
Structural heart disease	1 (0.9)	1 (1.1)	0
Prior treatment			
Statin therapy	41 (35.3)	31 (33.7)	10 (41.7)
Anticoagulation	8 (6.9)	3 (3.3)	5 (20.8)
Antiplatelet (any)	51 (44.0)	39 (42.4)	12 (50.0)
Aspirin	42 (36.2)	33 (35.9)	9 (33.3)
Clopidogrel	8 (6.9)	4 (4.3)	4 (16.7)
Aspirin/dipyridamole	2 (1.7)	2 (2.2)	0

Abbreviations: EDOU, Emergency Department Observation Unit; HTN, hypertension; CAD, coronary artery disease; A fib, history of atrial fibrillation; PVD, peripheral vascular disease; SD, standard deviation; TIA, transient ischemic attack.

Limitations

This study was conducted in a tertiary referral center that is a certified primary stroke center and has both an EDOU and a 24-hour MRI availability. Results may not be broadly generalizable to other health care settings. The observational design and nonrandom allocation of patients between the inpatient and the OU settings preclude meaningful clinical outcome comparisons between these 2 groups; however, we felt that reporting compliance with recommendations was appropriate since these represent evidence-based practices that would apply in either clinical setting.

Although our aim was to enroll a consecutive sample of patients with TIA presenting to the ED, the identification of patients for enrollment was dependent on clinician using the electronic TIA order set. Although it was initiated universally for OU patients, it is possible that it was used less consistently for patients with TIA that were admitted to the hospital directly from the ED; thus, this more severe patient population may be underrepresented in our sample. On the other hand, discharged patients with TIA were not included and given that

patients with TIA discharged from the ED are presumably viewed as lower risk of stroke, our TIA population may be skewed toward higher risk patients.

The number of patients enrolled was small and adverse events were rare, resulting in an imprecise estimate of the primary patient-centered outcome. Additionally, the script used for telephone follow-up was not previously validated, and about one-quarter of patients could not be reached for their follow-up telephone call. Although we did audit their electronic medical records, it is possible that events were missed if the telephone discussion failed to uncover relevant events or patients were treated outside of our hospital system. Nevertheless, our observed event rate was similar to that of other recently published TIA cohorts.^{27,29,30}

Another limitation stems from the inherent difficulty in determining which patients truly experienced a TIA. Our inclusion criteria were designed to capture the population most likely to be admitted to an EDOU, which included many patients with “possible” TIA. After diagnostic workup, we considered all patients without an alternative diagnosis to explain their neurological symptoms to be TIA cases. The strength of this approach is that our results reflect the real-world environment of the ED; however, interrater agreement for TIA diagnosis was only moderate ($\kappa = .46$). The greater degree of uncertainty regarding the final TIA diagnosis in our study likely contributes to the lower observed rates of infarct on MRI and subsequent stroke as compared to previous studies.²²

Discussion

The early evaluation of patients with TIA has received substantial attention since the high short-term risk of stroke following TIA was highlighted over 10 years ago.¹ Previous studies have suggested that occult infarct is commonly present among patients with TIA, and brain imaging with MRI offers more accurate diagnosis and possibly better prognostication.²³ This observational study examines the practical implications of incorporating routine MRI into a comprehensive TIA evaluation in an EDOU. Our results demonstrate that an expedited, EDOU-based TIA evaluation that includes DW MRI is feasible. However, clinical outcomes were similar to those reported for rapid-access outpatient TIA clinics^{4,5} and to EDOU protocols not routinely incorporating MRI,^{25,26} including at our own institution prior to implementation of the new pathway.²⁹

As with other studies of EDOU protocols for TIA,²⁵⁻²⁷ we observed high rates of clinical pathway compliance. Recommended testings such as brain MRI and carotid imaging were obtained more consistently among the EDOU TIA patients compared to the inpatient TIA cohort. The addition of MRI did not appear to significantly prolong the EDOU length of stay since patients with negative evaluations were, on average, discharged within 19 hours (ED plus EDOU length of stay), which is similar to the length of stay reported in other EDOU studies.²⁵⁻²⁷

Table 2. Performance and Yield of Diagnostic Studies Among the EDOU and Inpatient Subgroups.

Test	EDOU (n = 92)		Inpatient (n = 24)	
	# Performed, %	# Positive (% Yield)	# Performed, %	# Positive (% Yield)
Brain imaging ^a	92 (100)	12 (13.8)	24 (100)	5 (20.8)
DWI	87 (94.6)	12 (13.8)	15 (62.5)	4 (26.7)
CT	30 (31.6)	1 (3.6)	20 (83.3)	2 (10.0)
Both	23 (25.0)	N/A	11 (45.8)	N/A
Cervical vessels ^a	90 (97.8)	11 (12.2)	20 (83.3)	9 (45.0)
MRA	78 (84.8)	7 (9.0)	3 (12.5)	1 (33.3)
CTA	4 (4.3)	2 (50.0)	4 (16.7)	2 (50.0)
US	8 (8.7)	3 (37.5)	13 (54.2)	6 (46.2)
Telemetry ^a	92 (100)	4 (4.3)	26 (100)	3 (12.5)
Echo ^a	47 (51.1)	12 (25.5)	16 (66.7)	3 (18.8)
Neurology consult ^a	27 (29.3)	N/A	16 (66.7)	N/A
Negative evaluation	61 (66.3)	N/A	10 (41.7)	N/A

Abbreviations: EDOU, Emergency Department Observation Unit; DWI, diffusion-weighted imaging; CT, computed tomography; CTA, CT angiography; MRA, magnetic resonance angiography; US, ultrasound.

^aChi-square tests performed to compare rate of test performance; statistically significant differences ($P < .05$) are in bold.

Table 3. Description of Patients Who Experienced the Primary Outcome of Stroke or TIA Within 30 Days of Evaluation.

Patient	Event	Age	Gender	ABCD ²	DWI	Time to Event	Additional Risk Factors	Outcome
1	Stroke	60	Male	4	Positive	2 days	Carotid stenosis	The patient was admitted from the EDOU for vascular surgery consultation and preoperative clearance. Symptoms gradually returned between hospital days 1 and 2. Surgery was postponed due to worsening condition. Patient was discharged to subacute rehabilitation facility on hospital day 11. Discharge NIHSS 11.
2	Stroke	88	Female	4	Negative	1 day	Patent foramen ovale	Symptoms gradually recurred while in the observation unit overnight; repeat MRI demonstrated acute infarct. Patient discharged to acute rehab hospital day 5. Discharge NIHSS 10.
3	TIA	63	Male	6	Negative	2 days	None	Episode of "slowed" speech for about 1 hour, 1 day after discharge from the EDOU. The symptoms were thought to represent anxiety. No further diagnostic studies or interventions were undertaken.
4	TIA	63	Male	5	Negative	12 hours	None	Symptoms recurred in observation unit, but then resolved again. The patient was observed overnight, and repeat MRI the following day was also negative for acute infarct.
5	TIA	87	Female	3	Negative	13 days	Carotid stenosis, atrial fibrillation	This patient presented with transient recurrent speech disturbance 13 days after initial evaluation. She was being treated with antiplatelets rather than anticoagulation due to fall risk. On her second presentation, MRI demonstrated a cortical venous thrombosis without cerebral infarction. She was started on oral anticoagulation and had no further events.

Abbreviations: EDOU, Emergency Department Observation Unit; DWI, diffusion-weighted imaging; TIA, transient ischemic attack; NIHSS, NIH Stroke Scale; MRI, magnetic resonance imaging.

The overall yield of diagnostic testing in this study was high, with about 39% of patients having at least 1 positive test. Findings were present in nearly one-third of the patients with ABCD² scores <3 (supplemental table). Most patients with atrial fibrillation were recognized by history or on their

presenting ECG; only 1 additional patient was identified by telemetry monitoring. Carotid stenosis or cervical vessel dissection was common (16.8% of studies performed) and not predicted by clinical factors, supporting recommendations for universal screening of cervical vessels.⁶ Potential

cardioembolic sources were frequently identified by echocardiography—most often a PFO—however, these findings rarely impacted care.

Previous studies of MRI in TIA suggest that as many as one-third of the patients with an apparent TIA have infarcts when examined by MRI.²³ In our population of otherwise unselected ED-suspected TIA patients, acute infarcts on MRI were identified less often (15.2%). Furthermore, only 6.9% of patients had a positive MRI as their only positive test, suggesting that 15 MRIs would need to be obtained in order to identify 1 additional high-risk finding over a TIA evaluation not incorporating MRI. Since most research on MRI has been performed in TIA populations that were admitted to stroke units or were diagnosed by a neurologist,²³ our results may be explained by a higher rate of false-positive TIA identification by ED providers. Our rate of infarct on MRI was similar to that observed in another recent study of EDOU TIA patients (13%).²⁷ However, another recent study of hospitalized patients with TIA observed a low rate of infarct on MRI as well (11.1%),³¹ suggesting this phenomenon may not be limited to ED. The quality of the diffusion scan utilized to identify tissue infarction was not assessed in this study but is another potential reason for the lower yield of MRI. We used a standard diffusion protocol, and future investigations evaluating higher resolution and higher signal-to-noise protocols should be considered in this patient population.³²

Routinely incorporating MRI into an EDOU-based TIA clinical pathway is feasible with high levels of clinician compliance. However, we did not observe a clear clinical benefit of this approach in our population of ED-suspected TIA patients. Further studies are needed to identify the most efficient and cost-effective strategy for incorporation of MRI into the evaluation of patients with TIA.

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Supplemental Material

The online figure is available at <http://nhos.sagepub.com/supplemental>.

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