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APPLYING THE MODIFIED LOS ANGELES PREHOSPITAL STROKE SCREEN TO A RETROSPECTIVE COHORT OF CHILDREN

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ABSTRACT

Introduction: Childhood acute ischemic stroke is rare but increasingly recognized, with a variety of causes including thromboembolism, arteriopathy, prothrombotic states, systemic illness, and trauma. Childhood stroke is frequently under-recognized, causing delays in seeking care and delays in diagnosis. Prehospital stroke scales have been widely validated in adults. The Modified Los Angeles Prehospital Stroke Screen (mLAPSS) is one tool used in the prehospital setting but not validated in children. Our goal was to determine in a retrospective cohort whether children with acute stroke had a positive mLAPSS score.

Methods: We performed a retrospective case series of patients less than 18 years old with a final diagnosis of acute ischemic stroke admitted to our pediatric hospital between 2014 and 2024. Demographics, presenting symptoms, mode of hospital arrival, hospital results and interventions, and final diagnosis were recorded. We attempted to determine mLAPSS criteria from earliest patient contact available, whether prehospital or emergency department records.

Results: Seventy patients with 82 stroke episodes were evaluated during the study period. Of those with past medical history, the most common were a cardiac defect or sickle cell disease. Median time from symptom onset to presentation was one day. Half of the patients presented by private vehicle. The most common symptom was a new focal weakness, but the majority of patients had more than one symptom. Documentation of grip strength and arm drift was uncommon. Only one patient had clear documentation of all three components of the mLAPSS. The etiology of stroke was uncertain in 27%, hypercoagulable in 23%, moyamoya or sickle cell disease in 23%, systemic disease in 15%, and cardiac disease in 12%.

Conclusion: While focal weakness, headache, and seizures were routinely documented in children with a final diagnosis of AIS, specific criteria of the mLAPSS, especially arm drift and grip strength, were rarely documented on initial examination.

INTRODUCTION

Childhood acute ischemic stroke (AIS) is increasingly being recognized and studied in the literature. The stroke rate in children is 1.72-13 per 100,000 people (deVeber et al., 2017; Hollist et al., 2021; Lehman et al., 2018). The incidence is highest in children less than five years of age, with the most common being less than one year of age (Ferriero et al., 2019). Childhood AIS is more

common in boys than girls and more common in Black and Asian children (Ferriero et al., 2019). The risk factors for pediatric AIS are cardiac disease-causing thromboembolism, arteriopathies including sickle cell disease and moyamoya disease, prothrombotic states, traumatic vascular injury, and inflammatory etiologies such as systemic lupus erythematosus (deVeber et al., 2017; Ferriero et al., 2019; Sobu et al., 2019).

The most common presenting symptom of AIS in children is hemiplegia, which is regularly associated with facial weakness and speech issues (Arends et al., 2024; Baldovsky & Okada, 2020; Camacho-Sampaio et al., 2024; Hidalgo et al., 2018; Hollist et al., 2021; Mackay et al., 2011; Veber et al., 2017; Yock-Corrales et al., 2018). Children are more likely to have lower GCS and seizures than adults (Baldovsky & Okada, 2020). This includes 61% of children presenting with diffuse symptoms such as headache, vomiting, and decreased level of consciousness, and 29% of patients presenting with seizures (Baldovsky & Okada, 2020; deVeber et al., 2017).

Childhood AIS is frequently under-recognized by family and practitioners. 76% of patients presented after 6 hours of symptoms (Hartman, 2009). Less than half of patients' families considered stroke or called for an ambulance (Mackay et al., 2016). The time to diagnosis by health care practitioners is frequently prolonged, with the median time to radiographic confirmation being 15-24 hours (Braun et al., 2006; Ferriero et al., 2019; Rafay et al., 2009). Pediatric AIS can have devastating long-term symptoms, with 20-50% of children moderately to severely impaired, thus making advances in treatment and decreasing time to treatment paramount (Hollist et al., 2021; Mackay et al., 2017).

Early identification of adult stroke is recognized as a key component of treatment, with national benchmarks and educational campaigns for not only health care practitioners but the public alike on the importance of quickly recognizing stroke symptoms. In the prehospital setting, this includes utilizing emergency medical services (EMS) specific scoring systems to appropriately triage patients to stroke centers. One such tool is the Rapid Arterial Occlusion Evaluation (RACE) scale which evaluates facial palsy, arm motor impairment, leg motor impairment, head and gaze deviation, and hemiparesis. A RACE scale value of greater or equal to five showed a sensitivity of 0.85, a specificity of 0.68, a positive predictive value of 0.42, and a negative predictive value of 0.94 for detecting a large vessel occlusion. Another tool is the Modified Los Angeles Prehospital Stroke Screen (mLAPSS), which is used widely in our local prehospital systems. The mLAPSS has a sensitivity of 91% and sensitivity of 97% in adults but has not been studied specifically in children (Kidwell et al., 2000).

To expedite diagnosis and potential treatment, early recognition of stroke symptoms in children is equally important. Treatment for these patients begins in the prehospital setting with the ability to accurately triage these patients to stroke centers. The Pediatric RACE scale was specifically adapted from the adult RACE scale for use in children and evaluated 50 children in a 2024 study (Turón-Viñas et al., 2024). There was good interrater reliability, but small numbers with only 18 confirmed strokes. Given the widespread use of mLAPSS in our regional EMS system, we wanted to discover if this score could be applied to children. Before studying this prospectively, our group elected to evaluate a group of pediatric patients diagnosed with AIS and retrospectively evaluate how commonly the components of the mLAPSS were obtained on initial assessment.

Our primary goal was to determine if pediatric patients with an ultimate diagnosis of AIS or TIA had an arrival or prehospital mLAPSS score concerning for acute stroke. Secondary goals were to describe the presenting symptoms of these patients and ultimate stroke etiology.

METHODS

We performed a retrospective case series of all patients less than 18 years of age with a final diagnosis of acute ischemic stroke admitted to our hospital from 2014 to 2024. Our setting is a pediatric tertiary care center serving a population of approximately 1.3 million children. The hospital has 24-hour pediatric neurology and neurosurgery services.

Using a standardized data collection sheet and two data collectors not blinded to the study outcome, data were obtained from the EMS report, the ED record, and the hospital record. The following were collected: demographics, presenting symptoms, length of symptoms, method of arriving at the hospital, medical history, imaging and lab results, interventions, and final diagnosis. We attempted to determine mLAPSS from the earliest patient contact available, either from prehospital records, or if unavailable, from emergency department records. The presenting symptoms we recorded included focal weakness, altered mental status, headache, speech difficulty, dizziness or lightheadedness, visual change, and new or recurrent seizure. We determined etiology based on the final diagnosis of the inpatient discharge summary. If hypercoagulable testing was still pending, then follow-up visits were reviewed and final diagnosis determined by outpatient neurologist was recorded.

The mLAPSS examination criteria involves facial asymmetry, grip strength and arm strength (see Table 1), and the mLAPSS considered positive if all of the following criteria are met: 1) no history of seizures or epilepsy; 2) age 40 years or older; 3) at baseline, patient is not wheelchair bound or bedridden; 4) blood glucose between 60 and 400 mg/dL; and 5) obvious asymmetry-unilateral weakness with any of the forementioned motor exams.

	Normal	Right	Left
Facial Smile/Grimace	☐	☐ Droop	☐ Droop
Grip	☐	☐ Weak Grip ☐ No Grip	☐ Weak Grip ☐ No Grip
Arm Strength	☐	☐ Drifts Down ☐ Falls Rapidly	☐ Drifts Down ☐ Falls Rapidly

Table 1. Modified Los Angeles Prehospital Stroke Screen.

Descriptive statistics were used; nonparametric data was presented in medians and interquartile ranges. Patients were excluded if a stroke was determined to have occurred in the hospital or if deemed primarily traumatic or hemorrhagic. This study was approved by our hospital's institutional review board (IRB). Being a retrospective chart review, informed consent was waived by the IRB.

RESULTS

There were 70 patients with a final diagnosis of non-traumatic, non-hemorrhagic AIS or TIA during the study period. Due to recurrent stroke episodes, there were 82 total AIS or TIA episodes. Twenty-eight patients were female; 42 patients were male. The median age was 8 years (IQR 4-13 years). Of those with known past medical history, the most common was a cardiac defect in 14 patients and 6 patients with sickle cell disease. Three

patients had known moyamoya disease. Two patients had active leukemia on chemotherapy.

Median time from symptom onset to presentation was one day (IQR 2 hours to 2.75 days). In one patient there was insufficient documentation for how long the symptoms had occurred; in one patient the symptoms had been intermittent for 3 weeks, and one patient had a limp for 6 months. Approximately half of the patients came to the ED by private vehicle and not by ambulance (see Table 2). In the patients that arrived at the ED via ambulance, only 55% had EMS records available to review within the hospital's electronic medical record.

	n
Arrival to hospital	
By private vehicle	42 (51%)
By ambulance	18 (22%)
Uncertain	22 (27%)
Number of Presenting Symptoms	
Only 1 symptom	29 (35%)
2 symptoms	33 (40%)
3 symptoms	14 (18%)
>3 symptoms	6 (7%)
Types of Symptoms*	
New focal weakness	53 (65%)
Confusion	25 (30%)
Headache	24 (29%)
Speech deficit	22 (27%)
New or recurrent seizure	18 (22%)
Dizziness / lightheaded	12 (15%)
Vision change	9 (11%)
**Note. The total percentages add up to more than 100% because most patients had more than 1 symptom.*	

Table 2. Arrival and symptoms.

There were 30 patients who presented with only one symptom, the most common being a new focal weakness. The rest of the patients had more than one presenting symptom (see Table 2). While the majority of patients had weakness documented, specific mention of facial asymmetry or droop varied. Documentation of grip strength and arm drift was uncommon. Forty-one patients had facial symmetry documented, with 20 patients with a facial droop and 21 patients with normal symmetry. Only 9 patients specifically had grip strength documented, with 7 patients having a weak grip and 2 patients with a normal grip. Eleven patients had arm drift documented, including 4 patients with arm drift and 7 with no arm drift. Only one patient in our cohort had clear initial documentation of all three components of the mLAPSS.

In 11 of the encounters, we were unable to find an initial glucose test recorded. For the rest of the encounters, the earliest glucose recorded was a range of 67-345 mg/dL with a median of 100 (IQR 87-118).

A non-contrast, head computed tomography (CT) was the first diagnostic study in 63 patients, of which 60 went on to have confirmatory magnetic resonance imaging (MRI). Nineteen patients had MRI as the initial imaging test. Sixty-seven patients had either CT angiogram or MRI angiogram as part of continued stroke workup. The causes of stroke episodes included hypercoagulable in 23%, systemic disease in 15%, moyamoya in 13%, cardiac in 12%, sickle cell disease in 10%, and uncertain in 27%. Five patients had recurrent AIS episodes during the study period, including 2 patients with sickle cell disease with 6 and 2 strokes, respectively; one patient with MELAS syndrome (mitochondrial encephalopathy, lactic acidosis, stroke-like episodes) with 5 strokes; one patient with arrhythmogenic cardiomyopathy with 2 strokes; and one patient with adenosine deaminase deficiency with 2 strokes.

For initial treatment, 36 patients were placed on aspirin and 22 patients were placed on heparin or low molecular weight heparin. Six patients were sent for attempted thrombectomy with neurointerventional radiology. One patient had a carotid stent placed for a carotid dissection. Two patients required emergent craniectomy for increased intracranial pressure. Both cases were for large cerebral venous thromboses.

DISCUSSION

While focal weakness, headache, and seizures were routinely documented in children whose final diagnosis was AIS, specific motor criteria of arm drift and grip strength were rarely described in initial documentation. Similar to previous studies, new focal weakness was the most common presenting symptom. The frequency of focal weakness is a characteristic seen in both adult and pediatric strokes. Diffuse symptoms of confusion, headache, and seizure were common in children, which is less observed in adults.

This study has significant limitations including that, being retrospective, documentation of neurologic exam was not standardized and showed a high degree of variability in what was and was not written. It is possible that many of these patients specifically had grip strength and facial asymmetry evaluated, but this was not documented.

Multiple prior studies have shown a significant delay in time to diagnosis of childhood AIS (Braun et al., 2006; Hartman et al., 2009; Rafay et al., 2009). There is an opportunity to shine a light on the need for improvement in the awareness of AIS as a differential diagnosis in any patient with concerning symptoms and need for urgent diagnostics.

The average time to presentation was significant at one day. Only half of patients' family members believed the symptoms were serious enough to warrant calling for an ambulance. More education should be implemented for the public regarding recognition of early stroke symptoms at any age, not just in adults. Public education campaigns such as BE-FAST (Balance loss, Eyesight changes, Face droop, Arm weakness, Speech difficulty, Time to call 911 immediately) are focused on adult cohorts, but there is an opportunity to include that strokes can happen in children and are time-dependent.

Pediatric AIS is a game of diminishing returns. Delays in seeking care, delays in routing to the correct center, delays in consideration of stroke, and delays in diagnostics can all lead to critical missed opportunities to intervene. In the care of adult stroke, each metric is carefully monitored: time to provider evaluation, time to CT, time to CT reading, time to thrombolytics, and time to transfer or neurointerventional radiology. Delays at any step can lead to the inability to administer potential treatment for a life-altering event. Future studies should focus on developing a pediatric prehospital screening tool that accurately includes the most common symptoms and risk factors.

CONCLUSIONS

While focal weakness, headache, and seizures were routinely documented in children with a final diagnosis of acute ischemic stroke, specific criteria of the mLAPSS, especially arm drift and grip strength, were rarely documented on initial examination. Future studies should focus on determining and validating a specific pediatric prehospital stroke scale. Stroke campaigns should include pediatric specific teaching to improve public awareness of this diagnosis.

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