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Pediatric Acute Stroke Protocol Implementation and Utilization Over 7 Years

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Objective To examine the implementation and utilization of a pediatric acute stroke protocol over a 7-year period, hypothesizing improvements in protocol implementation and increased protocol use over time.

Study design Clinical and demographic data for this retrospective observational study from 2011 through 2018 were obtained from a quality improvement database and medical records of children for whom the acute stroke protocol was activated. The initial 43 months of the protocol (period 1) were compared with the subsequent 43 months (period 2).

Results Over the 7-year period, a total of 385 stroke alerts were activated, in 150 children (39%) in period 1 and 235 (61%) in period 2, representing a 56% increase in protocol activation. Stroke was the final diagnosis in 80 children overall (21%), including 38 (25%) in period 1 and 42 (19%) in period 2 (P = .078). The combined frequency of diagnosed stroke, transient ischemic attack (TIA), and other neurologic emergencies remained stable across the 2 time periods at 39% and 37%, respectively (P = .745). Pediatric National Institutes of Health Stroke Scale (PedNIHSS) documentation increased from 42% in period 1 to 82% in period 2 (P < .001). Magnetic resonance imaging (MRI) was the first neuroimaging study for 68% of the children in period 1 vs 78% in period 2 (P = .038). All children with acute stroke received immediate supportive care.

Conclusions Pediatric stroke protocol implementation improved over time with increased use of the PedNIHSS and use of MRI as the first imaging study. However, with increased utilization, the frequency of confirmed strokes and other neurologic emergencies remained stable. The frequency of stroke and other neurologic emergencies in these children affirms the importance of implementing and maintaining a pediatric acute stroke protocol. *(J Pediatr 2020;■:1-7)*.

Pediatric stroke is recognized as a major cause of death and disability in children.[1,2] The combined incidence of ischemic and hemorrhagic stroke is 2.0-5.9 per 100 000 children per year.[2-4] However, timely and accurate diagnosis of stroke in children continues to be difficult. Over the past decade, there has been increasing interest in creating acute stroke protocols within children's hospitals to help facilitate the recognition, diagnosis, and treatment of stroke.[5-9] A recent American Heart Association scientific statement on the management of stroke in neonates and children recommends that centers establish systems and pathways for hyperacute pediatric stroke care.[10] In our institution, a pediatric acute stroke protocol (**Figure 1**; available at www.jpeds.com) has been in place for 8 years; during the first 7 years of the protocol, more than 350 children were rapidly evaluated.

We hypothesized that with time and exposure to the pediatric acute stroke protocol, improvements would be demonstrated in neuroimaging, interventions, and supportive care for children with a suspected stroke. We assessed indicators of pediatric acute stroke protocol implementation for improvement over a 7-year time period, including the use of magnetic resonance imaging (MRI) as the first neuroimaging study for children with stroke-like symptoms, use of the Pediatric National Institutes of Health Stroke Scale (PedNIHSS)[11] to assess stroke severity, provision of intravenous (IV) fluids and supportive care for children with acute stroke, and discharge on antithrombotic (antiplatelet or anticoagulant) medication for children with confirmed ischemic stroke.

CT	Computed tomography
ED	Emergency department
ICU	Intensive care unit
IV	Intravenous
MRI	Magnetic resonance imaging
PedNIHSS	Pediatric National Institutes of Health Stroke Scale
TIA	Transient ischemic attack
tPA	Tissue plasminogen activator

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Methods

Our freestanding children's hospital, Monroe Carell Jr. Children's Hospital at Vanderbilt, serves a referral area of approximately 2.5 million people and has an average of 50 000 emergency department (ED) visits and 16 000 admissions annually. Hospital-wide education regarding our stroke protocol has occurred annually during the study period, with a specific focus on pediatric residents, pediatric emergency medicine and intensive care fellows, and nurses. Pediatric stroke alerts are paged through a central paging system used for the hospital code system and are prospectively logged through this system. Each stroke alert is then entered in a Research Electronic Data Capture (REDCap)[12] quality improvement database. An additional radiology database is used for quality improvement and review of utilization of the pediatric stroke protocol for MRI comprising a limited-sequence brain MRI focused on detecting acute ischemia with diffusion-weighted imaging, hemorrhage with a gradient recalled echo sequence, and major structural abnormalities with T1 and T2 axial sequences. Vessel imaging with time-of-flight magnetic resonance angiography of the head and neck is added if ischemia or hemorrhage is apparent or TIA is suspected.

A pediatric stroke alert is activated at our center when a child presents with focal neurologic deficits or other concerns for stroke within 48 hours of symptom onset. The goal of the protocol with this fairly long time window is early identification of children with stroke to provide timely treatment, including appropriate supportive care, acute stroke interventions, and antithrombotic agents for secondary ischemic stroke prevention, which may improve outcomes. When a stroke alert is activated, patients are evaluated within 15 minutes by an in-house neurology resident. Urgent neuroimaging is obtained; MRI of the brain is preferred and is available 24 hours a day. However, there are some limitations to urgent imaging if anesthesia is required or if imaging is necessary between 12:00 a.m. and 5:00 a.m., when the MRI technician must be called in from home.

Head computed tomography (CT) is obtained first when mandated by the clinical scenario, including high clinical suspicion for hemorrhagic stroke, contraindications to MRI, or when there will be a significant delay in obtaining an MRI due to problems of MRI availability, anesthesia availability, or other patient factors. When necessary, anesthesia for stroke alert patients entails general anesthesia with an endotracheal tube or laryngeal mask airway. There is a stroke alert order set to guide workup and supportive care for these children. All patients are discussed with the on-call child neurology attending at the time of stroke alert. The stroke-trained child neurology faculty member and the neurointerventionalist are available for consultation to guide neuroimaging, evaluation, and treatment as needed.

Patients aged 1 month to 18 years old were identified through the aforementioned databases, and additional details of care were entered retrospectively into the study database. Clinical and demographic information was obtained from the patients' medical records. In an effort to identify any missed strokes, radiology reports were also searched for children diagnosed with stroke by imaging without a pediatric stroke alert page. Key word searches were performed in the MRI reports obtained over a 2-year period from January 2013 through December 2014. Key words included "stroke" and "cerebral ischemia."

Here the term "stroke" refers to both ischemic and hemorrhagic strokes. Patients were classified as having hemorrhagic stroke when neuroimaging showed isolated intraparenchymal hemorrhage or intraparenchymal hemorrhage with intraventricular hemorrhage. Hemorrhagic transformation of ischemic stroke was classified as ischemic stroke. Cerebral venous sinus thrombosis and venous infarctions were excluded.

We compared the initial 43 months of pediatric acute stroke protocol utilization, April 2011 through October 2014 (period 1) with the subsequent 43 months, November 2014 through May 2018 (period 2). Descriptive statistics including frequency with percentage and median with IQR were used for categorical and continuous variables, respectively. Associations between categorical variables were assessed with the χ^2 or Fisher exact test if any value was <5. Wilcoxon rank-sum tests were used to compare continuous variables such as PedNIHSS score between the 2 time periods. A 2-sided P value <.05 was considered to indicate statistical significance. All statistical analyses were conducted in Stata 13.0 (StataCorp, College Station, Texas). The hospital's Institutional Review Board approved this study, and the need for informed consent was waived.

Results

Over the 7-year study period, the pediatric acute stroke protocol was activated 385 times: 150 times in period 1 and 235 times in period 2. These 2 periods are compared in Table I. Stroke protocol activation increased by 56% from period 1 to period 2 along with a decline in the median age from 11 years (IQR, 7-15 years) to 9 years (IQR, 3-14 years) (P = .006). Patient location when the stroke alert was called differed between the 2 periods, with 91% of stroke alerts called from the ED in period 1 vs 69% in period 2, due primarily to increased use of the protocol for intensive care unit (ICU) and floor patients. PedNIHSS utilization improved over time; the stroke scale was documented in only 42% of patients (63 of 150) in period 1, compared with 82% (193 of 235) in period 2 (P < .001).

Neuroimaging was completed in 149 of 150 children during period 1 and in 211 of 235 children in period 2. In the second period, the stroke alert was cancelled after rapid evaluation by the neurology service in 24 children (10%). These patients did not receive urgent neuroimaging due to a low suspicion for stroke as the primary diagnosis and a need for other, more urgent workup, including electroencephalography or a more detailed neuroimaging protocol. Only 1 patient in period 1 had a stroke alert cancelled. The

Table I. Demographics, patient location, and time-to-imaging for 385 pediatric stroke protocol activations in periods 1 and 2

Parameters	Period 1 (N = 150)	Period 2 (N = 235)	*P* value
Age, y, median (IQR)	11 (7-15)	9 (3-14)	.006
Male sex, n (%)	75 (50)	122 (52)	.714
PedNIHSS score documented, n (%)	63 (42)	192 (82)	<.001
PedNIHSS score, median (IQR)	3 (1-7)	4 (1-12)	.067
Stroke alert from ED, n (%)	136 (91)	163 (69)	<.038
Stroke alert from ICU, n (%)	7 (5)	35 (15)	<.002
Stroke alert from floor, n (%)	7 (5)	37 (16)	.001
MRI as the first imaging study	102/149 (68)	165/211 (78)	.038
Sedation needed for imaging, n (%)	17/149 (11)	33/211 (16)	.253
Door-to-imaging time (ED only) for those in the thrombolysis window, min, median (IQR)	101 (80-132); n = 43	79 (58-121); n = 58	.058
Confirmed stroke as final diagnosis, n (%)	38 (25)	42 (18)	.078
Nonstroke neurologic emergency n (%)	19 (13)	37 (17)	.331

first imaging study obtained was MRI in the majority of the patients during both periods but improved over time (68% in period 1 vs 78% in period 2; *P* = .038). The average door-to-imaging time in children for whom a stroke alert was called in the ED and who were also within the 4.5-hour time window for IV thrombolysis was 101 minutes (IQR, 80-132 minutes) in period 1 vs 79 minutes (IQR, 58-121 minutes) in period 2 (*P* = .058). Only 1 child in period 1 and 6 children in period 2 received anesthesia for MRI and were within this 4.5-hour window. These small numbers made valid statistical comparison of time to imaging with sedation vs without sedation impossible. Overall, anesthesia was used in 17 patients (11%) in period 1 vs 33 (14%) in period 2. Of note, some of these children were already intubated and sedated, typically in the ICU, at the time of stroke alert. Only 4 children (3%) in period 1 and 14 (6%) in period 2 needed new sedation for neuroimaging.

Final Diagnosis

Nonstroke neurologic emergencies were diagnosed in 56 children (15%). Over the 2 periods, the combined frequency of stroke, TIA, and other neurologic emergencies identified via rapid evaluation during the pediatric stroke alert process remained stable at 39% and 37%, respectively (*P* = .745). The most common stroke mimics diagnosed were seizure, migraine, altered mental status, functional neurologic disorder, nonspecific weakness, and Bell's palsy (**Figure 2**). Nonstroke neurologic emergencies (**Figure 3**; available at www.jpeds.com) included new central nervous system malignancy in 13 children, meningitis/encephalitis in 12, posterior reversible encephalopathy syndrome in 8, metabolic emergency in 6, methotrexate toxicity in 5, acute disseminated encephalomyelitis in 3, cerebral venous sinus thrombosis in 3, and acute neurosurgical emergencies in 6, including acute hydrocephalus, epidural abscess, and subdural hematoma.

A total of 80 patients were diagnosed with stroke via activation of the pediatric acute stroke protocol (**Table II**); 58 children (74%) had ischemic stroke, and 22 (26%) had hemorrhagic stroke. For children with a final diagnosis of stroke, the median PedNIHSS score was 7.5 (IQR, 4-15) in period 1 and 10 (IQR, 3-15) in period 2 (*P* = .156). All 80 children received immediate supportive care via utilization of a stroke alert order set that includes IV fluids and laboratory testing. Of the 55 children with ischemic stroke who survived to hospital discharge, 49 (89%) were sent home on antithrombotic therapy. Of those not on antithrombotics, 5 had medical contraindications and 1 did not have an obvious current medical contraindication to antithrombotic therapy though had a remote history of subarachnoid hemorrhage. Ten children with stroke died, including 4 children in period 1 and 6 children in period 2. Death was more common in patients with hemorrhagic stroke (n = 7) compared with those with ischemic stroke (n = 3) and in patients who were in the already in the

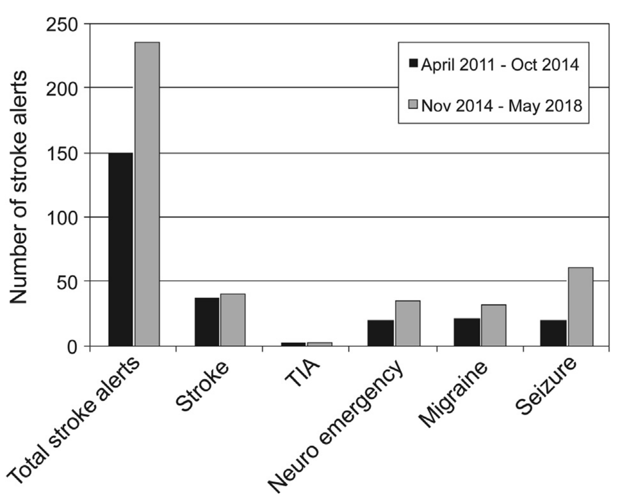

Figure 2. Pediatric stroke alerts: comparison over the 2 time periods. Bar graph shows that over two equal time periods, spanning a total of 7 years, the volume of stroke alerts increased but the frequency of final diagnosis of stroke, TIA, other neurologic emergency, migraine, and seizure was similar.

Table II. Pediatric stroke protocol implementation and characteristics of children with stroke (N = 80)

Characteristics	Total/overall	Period 1 (N = 38)	Period 2 (N = 42)	*P* value, period 1 vs 2
Age, y, median (IQR)	8 (3-13)	12 (7-15)	10 (3-10)	.133
Male sex, n (%)	47 (58)	24 (63)	23 (55)	.446
Ischemic stroke, n (%)	58 (73)	26 (68)	32 (76)	.437
Hemorrhagic stroke, n (%)	22 (27)	12 (32)	10 (24)	.437
PedNIHSS score documented, n (%)	50 (63)	13 (34)	37 (88)	<.001
PedNIHSS score, median, IQR	8 (3-15)	7.5 (4-15)	10 (3-15)	.156
MRI as first imaging, n (%)	49 (63)	22 (58)	27 (64)	.558
CT as first imaging, n (%)	31 (39)	16 (42)	15 (36)	.558
IV fluids and supportive care per order set, n (%)	80 (100)	38 (100)	42 (100)	NA
Discharged on antithrombotics (ischemic stroke only; n = 55 survivors), n (%)	49 (82)	22 (82)	27 (79)	.337
Medical contraindication to antithrombotics, n (%)	5 (9)	2 (8)	3 (10)	.729
No contraindication, antithrombotic not prescribed, n (%)	1 (2)	1 (4)	0	.290

NA, not applicable.

hospital at the time of stroke alert activation (9 of the 10 who died). Stroke was the cause of death in only 2 children, both of whom had hemorrhagic stroke and serious chronic illness. The other 8 children died of other causes within 30 days of stroke.

Interventions

No child received IV tissue plasminogen activator (tPA) in our facility, due primarily to delayed presentation for medical care and rapid improvement. Two patients in period 1 (7% of children with ischemic stroke) and 3 patients in period 2 (9%) underwent endovascular thrombectomy (Table III). Four other children underwent an emergency neurosurgical procedure, including hemicraniectomy for ischemic stroke in 1 patient and craniectomy for hematoma evacuation for hemorrhagic stroke in 3 patients.

Missed Stroke and Prolonged Time to Stroke Protocol Activation

We carefully searched for acute strokes missed by our pediatric stroke alert process. MRI reports were examined for the words "cerebral ischemia" and "stroke" for 2 years during the study period (January 2013 to December 2014), and 188 MRI reports were reviewed. This process did not yield any missed strokes. Fifteen MRIs did show evidence of acute stroke; however, 8 of these cases were already identified by stroke alert activation. The other 7 children were not considered to have a missed stroke because they were either critically ill children with suspected ischemic stroke not stable for transport for neuroimaging, so that neurology was consulted but stroke alert was not paged, or children with traumatic brain injury or central nervous system infection with ischemic brain injury suspected and detected on head CT performed before MRI.

In addition, ED cases involving a prolonged time from ED arrival to stroke alert called (>60 minutes) were reviewed. In period 1, there were 22 cases with a prolonged time (>60 minutes) from ED arrival to calling of the stroke alert. Of these cases, 3 children were ultimately diagnosed with ischemic stroke. In period 2, there were 39 patients with prolonged time from triage to stroke alert activation and 5 of these had acute ischemic stroke on imaging. Careful evaluation identified 8 children (2% of stroke alerts and 14% of children with ischemic stroke) for whom stroke diagnosis was delayed. The cause of the prolonged times appeared to be multifactorial; however, subtle symptoms (eg, low PedNIHSS score), young age, and nonspecific symptoms delayed the recognition of stroke-like symptoms. Of note, none of the children with delayed recognition would have been tPA candidates

Table III. Mechanical thrombectomy for ischemic stroke after pediatric stroke alert

Age, y	PedNIHSS score	Vessel occlusion and thrombectomy	Symptom onset to presentation at pediatric stroke center, min	History
18	10	MCA (right M1)	111	History of intellectual disability; presented with acute left hemiplegia.
5	22	Basilar	478	Healthy male with traumatic neck injury sustained while jumping on couch; unresponsive on arrival.
6	22	Basilar	400	Hypoplastic left heart syndrome; presented with altered mental status, unresponsive.
17	12	MCA (left M2)	225	Type 1 diabetes mellitus; presented with acute right hemiplegia, aphasia; tPA at referral hospital, mechanical thrombectomy after transfer.
4	13	Basilar	5*	Complex congenital heart disease, on Berlin heart ventricular assist device; developed acute left hemiplegia and speech arrest.

MCA, middle cerebral artery.
*Child in intensive care unit at onset of symptoms.

based on the duration of symptoms at presentation or other medical comorbidities.

Discussion

Pediatric stroke protocol implementation at our center improved over the 7-year period. Protocol utilization by the ED and particularly by inpatient providers increased over time. Although the frequency of confirmed stroke or other neurologic emergency for which rapid neurologic evaluation was appropriate did not differ significantly over time (37% in period 1 and 39% in period 2), indicators of successful pediatric acute stroke protocol implementation, including the use and documentation of the PedNIHSS to assess stroke severity, increased. MRI as first neuroimaging study for most children with stroke-like symptoms also increased over time. MRI is the preferred first-line imaging in pediatric stroke, because CT is unable to differentiate common stroke mimics and has been reported to miss as many as 47%-84% of ischemic strokes in children that are later confirmed by MRI.[13,14]

Supportive care and IV fluids were provided to all children with acute stroke. In addition, the vast majority of children with ischemic stroke for whom secondary prevention with antithrombotic medication was indicated were started and discharged to home on these medications.

Most published accounts of pediatric stroke protocol utilization have not provided an assessment of children with stroke with a delayed or missed diagnosis.[5-7] Only 1 in 5 children for whom a pediatric stroke alert was activated had a final diagnosis of ischemic or hemorrhagic stroke. We searched carefully for children with delayed diagnosis of stroke, because the number of stroke mimics is significant. With radiology text searches, we were not able to identify any missed ischemic strokes. We did find 8 children (2%) for whom a pediatric stroke alert was not activated for >60 minutes after arrival to the hospital or after symptoms were noted for those already in the hospital. In these cases, pediatric neurology was frequently consulted, and the neurology team activated the stroke protocol after examining the child. It was difficult to discern retrospectively whether acute stroke was not recognized by the primary team or whether there was lack of familiarity with the pediatric stroke protocol and so a neurology consult was called instead of a stroke alert.

Time to imaging was quite long, including for children who were within the 4.5-hour time window for IV tPA administration at a median of 77 minutes in period 2. Another tertiary care center reported a shorter mean time of 54 minutes from ED arrival to neuroimaging in children who were candidates for tPA treatment.[15] Reasons for imaging delays included unavailability of MRI for children undergoing MRI as the first imaging study, required time for MRI screening, and complex transport for neuroimaging. Our institutional policy is that pediatric MRI scans in progress will not be interrupted for a stroke alert MRI unless the child is a candidate for acute stroke intervention (ie, thrombolysis or endovascular therapy). Even when this situation occurs, it takes time to halt a scan in progress; therefore, our imaging times reflect a short wait for scanner availability. In addition, stroke alerts for children with critical illness, including those on extracorporeal membrane oxygenation, often pose logistical challenges in transporting the child to the scanner. Children on extracorporeal membrane oxygenation and others who have a contraindication to MRI or a significant delay to MRI undergo CT head and CTA head and neck scans.

The increased frequency of stroke alert activation over the 7-year time period demonstrates an improved awareness of childhood stroke among providers. As described by Rafay et al, presentation of ischemic stroke is often erroneously attributed to other conditions that are significantly more common in children.[16] However, ongoing institutional education and improved awareness of presentation of pediatric stroke ideally will lead to consistent activation of the stroke alert pathway. Even with an increase in pediatric stroke protocol utilization over the 7-year period, the proportion of children with a final diagnosis of stroke did not decline. At our center, a stroke alert can be activated by any member of the medical team. One institution reported that evaluation by the pediatric neurology stroke team was required before activating their pediatric acute stroke pathway.[7] Although requiring neurology evaluation before protocol activation may slightly prolong the time to imaging, it also may more accurately identify children who are appropriate candidates for acute neuroimaging.

Our rate of acute stroke intervention is lower than other reports, with 8% of children with ischemic stroke in our cohort receiving off-label intervention with mechanical thrombectomy despite the presence of a dedicated, experienced pediatric neurovascular team. Currently, careful selection of patients seems consistent with the 2019 American Heart Association's scientific statement to exercise caution when considering the use of these devices in children.[10] However, lower rates of mechanical thrombectomy also may reflect patient differences that are not easily measurable. In one study, 18% of children with ischemic stroke received hyperacute therapy.[17] Another study described recanalization treatment in 13 children over a 40-month period, demonstrating the feasibility of hyperacute therapy in children.[18] Ongoing efforts to improve awareness of pediatric stroke in the community are needed. Less than one-half (20 of 58) of our patients with ischemic stroke had known and documented times of <4.5 hours—a current IV thrombolysis time window—from symptom onset to evaluation. Onset of stroke symptoms in children is often unclear and limits the use of hyperacute therapies. With the recent publication of 2 stroke clinical trials—Endovascular Therapy Following Imaging Evaluation for Ischemic Stroke trial (DEFUSE 3)[19] and Diffusion-Weighted Imaging or CT Perfusion Assessment with Clinical Mismatch in the Triage of Wake-Up and Late Presenting Strokes Undergoing Neurointervention with Trevo trial (DAWN)[20]—extending the time windows for mechanical thrombectomy in adults, we note that 38 of 58 children (65%) with ischemic stroke presented within 24 hours of symptom onset.

Programs have been implemented to improve prehospital identification of adults with stroke by emergency medical personnel, which can help decrease the time to diagnosis and intervention.[21] Unfortunately, these adult tools have been shown to perform poorly in children. In an Australian study, the Cincinnati Prehospital Stroke Scale had only 62% sensitivity and the Recognition of Stroke in the Emergency Room (ROSIER) had 67% sensitivity for stroke detection in children.[22] An Ohio-based study group found that the Central Ohio Trauma System Scale was unable to distinguish strokes from other conditions causing focal neurologic deficits in children.[23] Both groups concluded that adult stroke prehospital recognition tools were inadequate for children. Lehman et al outlined a number of key steps to improve pediatric stroke acute care, chief among them education of healthcare providers about stroke in children and development of improved pediatric stroke recognition tools.[24] We concur with these recommendations.

Strengths of our study include the large number of children evaluated over an extended period compared with other studies.[5-7,25] There was a comprehensive and thorough evaluation of all stroke alerts activated via review of both a quality improvement database, which includes all stroke alerts paged, and a radiology database, which includes all stroke protocol-specific MRIs ordered. In addition, we were able to screen for missed strokes via text word searches of a 2-year sample of radiology reports followed by review of charts to determine if a stroke had been missed, which has not been previously described in the literature in the context of evaluating protocol implementation. All 7 study years were not searched, owing simply to the volume of radiology reports and charts to review (>650). Many stroke-related terms could be text-searched from radiology reports. Because terms like "infarct," "restricted diffusion," and "hemorrhage" are often mentioned when there is no evidence of these pathologies, text searches of these terms produced thousands of radiology reports, and a review was not feasible, representing a limitation.

Other limitations of our study included data gathered via retrospective chart review and presumed missing data on children diagnosed with intracerebral hemorrhage. If diagnosis of hemorrhage was confirmed via head CT at a referring hospital, the acute stroke protocol might not have been used. Stroke alerts seem to have been called on more medically complex children with hemorrhagic stroke, who might not be representative of all children with hemorrhagic stroke. Finally, the time of symptom onset was unclear for many children who had a stroke alert called while an inpatient, often due to sedation for other medical conditions or procedures.

Successful and sustainable implementation of a pediatric acute stroke pathway over time requires frequent protocol evaluation and staff education to ensure appropriate protocol application. We believe that such quality improvement is the most important factor in decreasing the time to neuroimaging and improving stroke care. Staff education at our institution is composed of annual lectures given by our pediatric stroke neurologist to all levels of providers in departments with the highest rates of stroke protocol utilization, including the ED and ICU. Children with acute stroke will benefit from being evaluated in centers with stroke alert protocols in place, which have been shown to decrease the time to diagnosis and also to provide appropriate intervention and supportive management.[5-7,25] The fact that approximately 1 in 5 children with stroke protocol activation over 2 periods had a stroke and 37%-39% had stroke, TIA, or another neurologic emergency confirms that the time and effort required to implement and maintain a pediatric acute stroke protocol is worthwhile. ■

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Data Statement

Data sharing statement available at www.jpeds.com.

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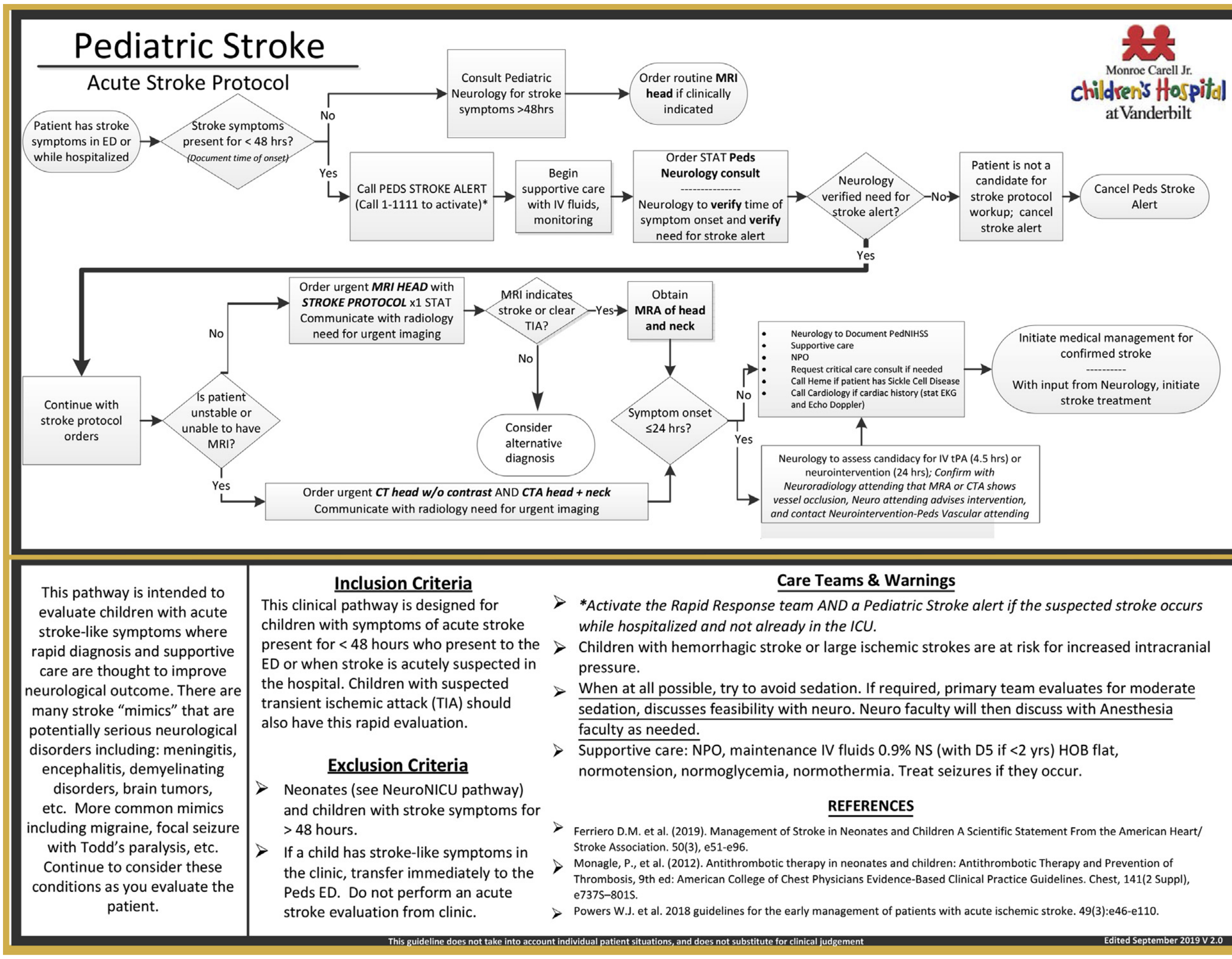

Figure 1. Pediatric stroke protocol flow diagram showing the protocol currently in use. Before the adult stroke mechanical thrombectomy trials published in 2016-2018,[19,20] the pediatric stroke intervention window was considered to be 4.5 hours for off-label IV tPA.

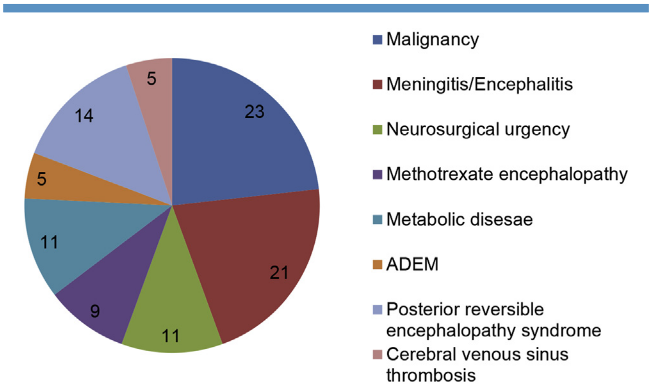

Figure 3. Nonstroke neurologic emergencies. The pie chart shows the frequency of other neurologic emergencies identified during stroke alert activations for n = 56/385 activations, including new central nervous system malignancy, meningitis/encephalitis, neurosurgical urgency, methotrexate leukoencephalopathy, metabolic disease, acute disseminated encephalomyelitis, posterior reversible encephalopathy syndrome, and cerebral venous sinus thrombosis.