Suspected Pediatric Stroke Clinical Pathway

October 2020

Inclusion criteria	Patients aged < 18 years who present with stroke-like symptoms* (see 'special considerations'), with symptom onset < 48 hours prior to presentation
Exclusion criteria	Patient with history of recent imaging that has excluded stroke, clinical determination that stroke is highly unlikely Patients aged 6 months to 5 years with fever and seizures without persistent focal deficits Patients with new-onset seizure without focal deficits/hemiparesis Patients with epilepsy presenting with seizure without persistent focal neurologic deficits
Outcomes/Goals	1. Create an efficient, timely, team-oriented, standardized approach for the evaluation, work up, and accurate diagnosis of children with suspected stroke
NURSE documentation	Chief complaint. Onset of symptoms, associated symptoms, medications, allergies, vital signs including cardiac monitoring. Focused neuro assessment. Evaluate for presence of braces. Q 15 minute vitals and neuro checks until stroke ruled out
INTERVENTIONS Initiate on arrival	ESI Triage level I or II Bedrest with HOB Flat Place topical Lidocaine (LMX) in anticipation of peripheral IV start ***or*** J-tip Place 2 pIV, draw labs Isotonic IV fluids for arterial ischemic stroke and cerebral venous thrombosis Oxygen to maintain SpO2 95% Transport to imaging goal: ***<15 minutes*** if revascularization candidate, worsening GCS, strong concern for ICH, ***120 minutes*** if not Evaluate need for pediatric Code White NPO Normothermia, goal temp < 37.5 C (APAP for T > 37.5 C)
DIAGNOSTICS	LABS: POC Chem 8 w/ H&H, CBG, BMP, CBC w diff, INR, aPTT, fibrinogen, T&S; 12 Lead ECG
PHYSICIAN (LIP) Notifications	•ED LIP evaluation within 10 minutes of arrival •Notify Pediatric Neurology if concern for acute stroke (IP consult peds neurology for possible stroke) •Notify Peds Neurosurgery for CT showing intracranial hemorrhage •Notify Pediatric Dentistry to remove braces for MRI if needed
Diagnostic Imaging	***IN DISCUSSION WITH NEUROLOGY:*** CT or MR depending on patient factors and availability of imaging, sedation
Medication	***TO BE ADMINISTERED ONLY AFTER DISCUSSION WITH NEUROLOGY:*** • Aspirin (3-5 mg/kg PO, max 81 mg) • Heparin (*infants*: 28 units/kg/hr; *children and adolescents*: 20 units/kg/hr) • TPA (0.9 mg/kg IV, max 90mg—first 10% pushed over 1 minute, remainder over 1 hour) • Anticonvulsant (if presented with seizures): Fosphenytoin 20 mg pE/kg for infants and children, phenobarbital 15mg/kg for neonates (maximum dose 1500mg PE)
ADMISSION	Directly to IR for thrombectomy if indicated, then PICU Otherwise, admit to PICU
Special Considerations: *Symptoms of stroke	**Arterial Ischemic Stroke (AIS):** Hemiparesis (esp combination of face+arm or face, arm, leg); aphasia (difficulty with speech or understanding); visual field cut; ataxia (esp with headache, dizziness, vomiting); dysarthria; hemisensory loss (esp one side of body and combination of face+arm or face, arm, leg); new onset focal seizures with post-ictal deficit **Acute Cerebral Venous Sinus Thrombosis (CVST):** Unremitting and escalating headache, repeated vomiting, and decreased mental status (often with 6th nerve palsy and papilledema) **Primary Intracranial Hemorrhage (ICH):** Hyperacute severe headache (esp if followed by decreased mental status); sudden and sustained LOC; either of above with focal neuro deficit

Clinical Pathway Decision Making Process

Suspected Pediatric Stroke (0-18 years)

October 2020

Immediate Actions:

1. Patient has **symptoms of stroke** and does not meet exclusion criteria
2. Determine time of onset of symptoms
3. Insert IV, place monitors, obtain labs
4. Consider bolus, start mIVF with NS
5. Bed rest, HOB flat, NPO
6. Consider Peds Code White
7. Consult Peds Neurology
8. Consult Peds Dentistry if braces

AIS: Hemiparesis, aphasia, dysarthria, visual field cut, hemisensory loss, new onset seizure with post-ictal focal deficit, ataxia, acute obtundation

CVST: Unremitting, escalating headache, vomiting, decreased MS

ICH: Hyperacute severe headache, sudden, sustained LOC, either with focal neuro deficit

First 15 Minutes: Goal to CT for Intervention Candidates

Strong concern for ICH or patient has worsening AMS?

NO

Patient age ≥ 4 - 8 years AND either:

- < 24hrs and sxs of anterior circulation stroke: hemiparesis or sensory loss, aphasia, focal weakness?
- < 48 hrs and sxs of posterior circulation stroke: ataxia, vertigo, dizziness, nystagmus, blurry vision, diplopia?

YES

Stat Head CT w/o contrast

YES

Possible revascularization candidate?**

NO

Moderate-high suspicion for stroke?

YES

NO

1. STROKE TEAM C/S and ***STROKE ALERT by Ped Neuro***
2. **CT/CT perfusion/CTA *OR* MRI Rapid Swift (T2, flair, DWI, MRA brain)**

TBD by Stroke Team

NO

YES

Can MRI/MRA be obtained w/in 2-3 hours?

NO

YES

Imaging Interpretation and Disposition

Evidence of hemorrhage?

YES

NO

Consult Ped Neurosurgery
Consider interventions for elevated ICP as appropriate

qbMRI with DWI

MRI wo contrast
MRA head wo
MRA neck wwo, dissection protocol

Evidence of ischemia/ thrombosis?

YES, BUT NOT THROMBOLYSIS CANDIDATE

Consult Ped Hematology
Consider anticoagulation, antiplatelet therapy
O2 to maintain SpO2 >95%
Maintain normothermia
Maintain normoglycemia
Vital Signs q1hr, neuro checks q15min
Consider intubation, hypertonic saline for large territory stroke
Admit to PICU

YES, THROMBOLYSIS CANDIDATE**

NO

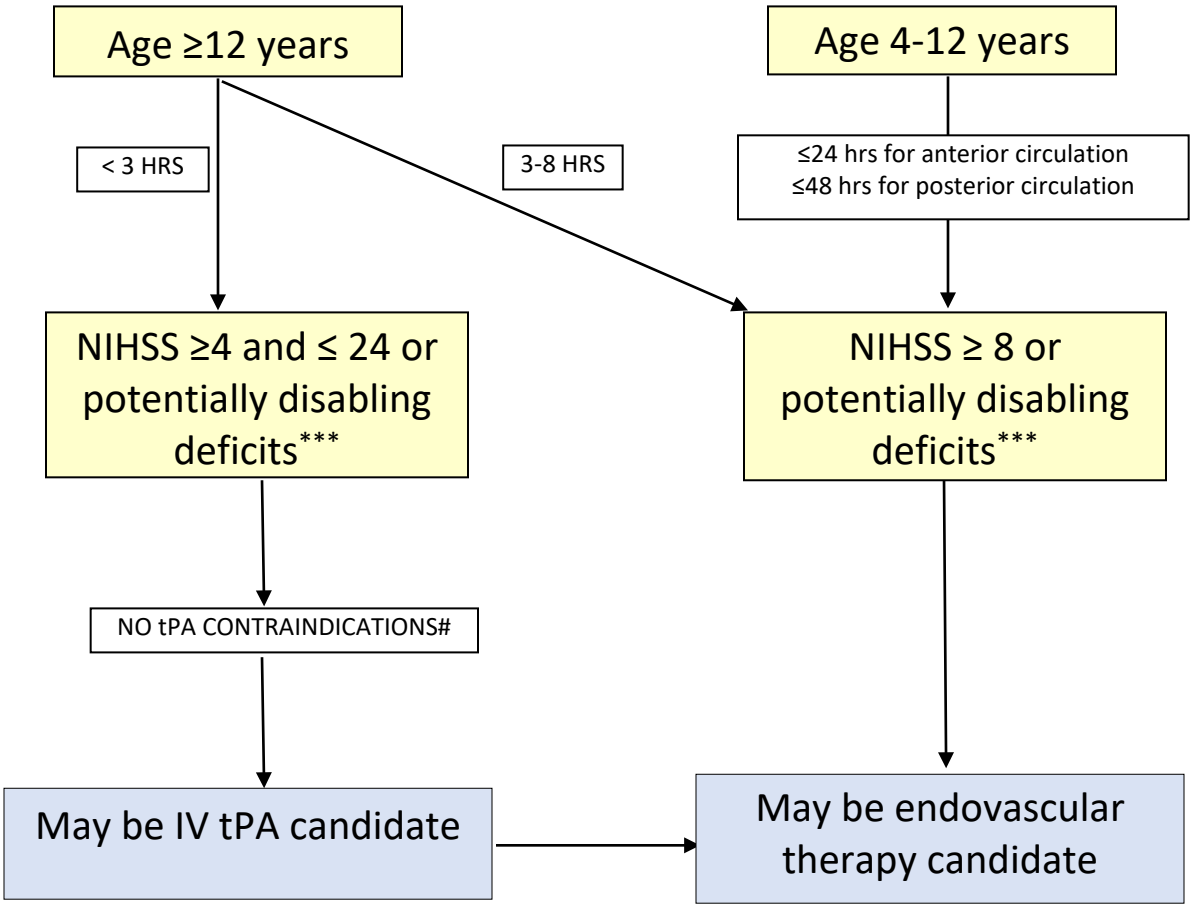
Normal imaging

GO TO ACUTE THERAPY FLOWCHART

Continue to seek and treat cause of presenting symptoms

**Acute Therapy Flowchart – Is Patient a Thrombolysis Candidate?

O2 to maintain SpO2 >95%
Maintain **normothermia** (< 37.5C)
Maintain **normoglycemia** (age <2 = D5; ≥2 = no dextrose unless hypoglycemic)
Maintain **normotension** (SBP between 50th %ile and 15% above the 95th %ile)
Maintain **normovolemia** (Isotonic fluid at maintenance rate, fluid bolus prn)
Vital Signs q1hr, neuro checks q15min
Peds neuro vs adult neuro to administer NIHSS
Consider intubation, hypertonic saline for large territory stroke



*****May be considered Disabling Deficits:**

- Complete hemianopsia
- Severe aphasia
- Visual or sensory extinction
- Any weakness limiting sustained effort against gravity
- Any deficits leading to NIHSS > 5
- Any remaining deficit considered potentially disabling

Exclusion criteria for thrombolysis:

Unknown time of symptoms onset
Pregnancy
Clinical presentation suggestive of SAH even if brain imaging is negative for blood
Patient who would decline blood transfusion if indicated
History of prior intracranial hemorrhage
Known cerebral arterial venous malformation, aneurysm, or neoplasm
Persistent systolic blood pressure > 15% above the 95th percentile for age while sitting or supine
Glucose < 50 mg/dL or > 400 mg/dL
Bleeding diathesis including platelets <100,000, INR > 1.4 (PT > 15s), or elevated aPTT more than upper limits of normal range
Clinical presentation consistent with acute myocardial infarction or post-MI pericarditis that requires evaluation by cardiology before treatment
Prior stroke, major head trauma, or intracranial injury within the past 3 months
Major surgery or parenchymal biopsy within 10 days (relative contraindication)
Gastrointestinal or urinary bleeding within 21 days (relative contraindication)
Arterial puncture at non-compressible site or lumbar puncture within 7 days (relative contraindication). Patients who have had a cardiac catheterization via a compressible artery are not excluded.
Patient with malignancy or within 1 month of completion of treatment for cancer
Patients with an underlying significant bleeding disorder. Patients with a mild platelet dysfunction, mild von Willebrand disease, or other mild bleeding disorders are not excluded

tPA Systolic BP parameters - Male

Age	50th %	95th %	>15% above 95th %	>20% above 95th %
1-4 years	90	112	129	134
5 years	95	113	130	136
6-10 years	96	121	139	145
11-18 years	105	140	161	168
>18 years	110	140	161	168

tPA Systolic BP parameters - Female

Age	50th %	95th %	>15% above 95th %	>20% above 95th %
1-4 years	90	111	128	133
5 years	94	113	130	136
6-10 years	96	121	139	145
11-18 years	105	131	151	157
>18 years	110	140	161	168

Stroke-related exclusion criteria:

Mild deficit (PedNIHSS < 4) at start of tPA infusion or at time of sedation for neuroimaging, if applicable
Severe deficit suggesting large territory stroke, with pre-tPA PedNIHSS > 24, regardless of the infarct volume seen on neuroimaging
Stroke suspected to be because of subacute bacterial endocarditis, moyamoya, sickle cell disease, meningitis bone marrow, air, or fat emboli
Previously diagnosed primary angiitis of the central nervous system or secondary CNS vasculitis Focal cerebral arteriopathy of childhood is not a contraindication.

Neuroimaging-related exclusions:

Intracranial hemorrhage on pretreatment head MRI or head CT, even petechial
Intracranial dissection (defined as at or distal to the ophthalmic artery)
Large infarct volume, defined by the finding of acute infarct on MRI involving one-third or more of the complete MCA territory involvement
Absence of occlusion on vascular imaging

Drug-related exclusions:

Known allergy to recombinant tissue plasminogen activator
Patient on anticoagulation therapy must have INR < 1.5
Patient who received heparin within 4 hours must have aPTT in normal range
LMWH within the past 24 hours (aPTT and INR will not reflect LMWH effect)

Suspected Pediatric Stroke Rationale

Goals of Clinical Pathway

1. Create an efficient, timely, team oriented, standardized approach for the evaluation, work up, and accurate diagnosis of children with suspected stroke

Data Considerations	Rationale		
Risk Factors	About 50% of children with stroke have a previously identified risk factor. Risk factors include:		
	Arterial Ischemic Stroke: Sickle Cell disease Congenital + acquired heart disease Hypercoagulable state Cerebral vasculopathy Infection (CNS and ENT)	Cerebral Venous Sinus Thrombosis: Chronic anemia Congenital + acquired heart disease Autoimmune disease Malignancy and treatment Dehydration Infection (CNS and ENT)	Hemorrhagic Stroke: AVM (32%) Intracranial aneurysm Hemophilia Coagulation disorders Neonate
Diagnosis	Stroke vs stroke mimics: Though many disorders mimic childhood stroke, it is difficult to reliably distinguish stroke mimics from true stroke based on symptoms. Furthermore, a significant number (20-80%) of pediatric patients with stroke symptoms will be found to have a true stroke syndrome. In addition to this, patients with stroke mimics will often have significant pathology on neuroimaging, including posterior reversible encephalopathy, vascular anomalies, and tumors among others, underscoring the need for prompt diagnostic evaluation in these patients.		
Imaging:	MRI is superior to CT in the diagnosis of acute ischemic stroke and is sensitive for hemorrhage; therefore, if readily available, may be used as the sole imaging modality. Additionally, limited evidence exists to recommend ultrafast MRI protocols for the diagnosis of acute ischemic stroke, though this has not been extensively studied, particularly in pediatric patients.		
Interventions: **IV TPA**	tPA is standard of care in adults who present with acute stroke within 3-4.5 hours, with 33% with good outcomes compared to 23% of controls. Symptomatic hemorrhage occurs in 6.4% of cases in adults. tPA is given in 2% of children with stroke, though benefit is unknown as there is no good RCT data. In one review of 99 children given tPA, there was a 4.9% hemorrhage rate, with no deaths (Nasr et al Pediatric Neurology 51 (2014) 624e631).		
Mechanical Thrombectomy	Several trials have demonstrated benefit in adults who present with large vessel occlusion within 6 hours for anterior circulation stroke where territory is not entirely infarcted. NNT is 3 to 7. There is little pediatric data. Risks include hemorrhage, stroke, vascular injury, limb injury; complication rate in adults 3-5%. 2015 guidelines suggest it may be reasonable for some patients < 18 yrs with large vessel occlusion within 6 hours.		
Special populations	**Perinatal and neonatal stroke:** Cranial ultrasound can be useful for hemorrhage and interventricular hemorrhage. However, given that 80% of perinatal and neonatal strokes are ischemic, and that transcranial ultrasound has poor sensitivity for ischemia, CT or MR are preferred if significant concern exists. **Sickle Cell Anemia:** Patients with SCA are at much higher risk than patients without SCA for all types of stroke, occurring 67 to 410 times as commonly. The mainstays of treatment of arterial ischemic stroke are hydration and exchange transfusion. Contact hematology immediately for these patients.		

References:

Roach SE, Golomb MR, Adams R, et al. Management of Stroke in Infants and Children: A Scientific Statement from a Special Writing Group of the AHA Stroke Council and the Council on CV Diseases in the Young. Stroke. 2008;39:2644-2691

Ladner TR, Mahdi J, Gindville MC, et al. Pediatric Acute Stroke Protocol Activation in a Children's Hospital Emergency Department. Stroke. 2015;46:2328-2331

Shellhaas RA, Smith SE, O'Tool E, et al. Mimics of Childhood Stroke: Characteristics of a Prospective Cohort. Pediatrics 2006: 118(2): 704-709

Rivkin MJ, Bernard TJ, Dowling MM, et al. Guidelines for Urgent Management of Stroke in Children. Pediatr Neurol 2016; 56: 8-17

Chalela JA, Kidwell CS, Nentwich LM, et al. "Magnetic resonance imaging and computed tomography in emergency assessment of patients with suspected acute stroke: a prospective comparison". Lancet 2007; 369(9558):293.

U-King-Im JM, Trivedi RA, Graves MJ, et al. "Utility of an ultrafast magnetic resonance imaging protocol in recent and semi-recent strokes". J Neurol Neurosurg Psychiatry 2005; 76(7): 1002

CHOP ED Pathway Stroke Management Process

CHOC Children's Acute Stroke Care Guidelines

Authors: Beech Burns, Jenny Wilson, Cydni Williams, Denise Langley

Reviewed/Approved: Peds Section Meeting (9/2016) , Pediatric Stroke Team (9/2016), Pharmacy (9/15/16) ; 3/2019; 10/2020