

Not Just For Adults!

Pediatric Stroke Care

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**Internal Medicine, Pediatrics, Pediatric Critical
Care**

The 19th Annual Stroke Symposium

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Disclosures

- **Nothing to disclose**
- **Except...**
 - **I am NOT a pediatric neurologist, radiologists, or hematologist!!**

Objectives

- **Discuss epidemiology and risk factors for pediatric stroke, and how it differs from adults**
- **Discuss barriers to pediatric stroke care**
- **Review common stroke mimickers in children**
- **Discuss diagnosis and management of acute ischemic stroke in children**
 - **Review indications for tPA in children-TIPS study**

Stroke Care

- Overall goal of stroke care
 - Minimize acute brain injury
 - Maximize patient recovery

The “**D's of Stroke Care**” D-mystifying recognition and management of Adult stroke.

- Detection: Rapid recognition of stroke symptoms
- Dispatch: Early activation and dispatch of emergency medical services (EMS) system by calling 911
- Delivery: Rapid EMS identification, management, and transport
- Door: Appropriate triage to stroke center
- Data: Rapid triage, evaluation, and management within the emergency department (ED)
- Decision: Stroke expertise and therapy selection
- Drug: Fibrinolytic therapy, intra-arterial strategies
- Disposition: Rapid admission to stroke unit, critical-care unit

Epidemiology

- WHO incidence of acute ischemic stroke
 - Adults 200/100,000
 - Children 1-2/100,000
 - Excludes neonatal stroke
 - Likely underestimated!

Pediatric Stroke

- Mortality rate 2-11%
- Persistent neurological deficit 68-73% of children with stroke
- Only $\approx 2\%$ of children with acute ischemic stroke receive tPA treatment in the US
- TIME IS BRAIN
 - Rapid identification, diagnosis, and treatment is crucial!

Barriers To Pediatric Stroke

- Practical Issues
 - Diagnosis is often delayed
 - Access to acute MRI and pediatric anesthesia is often limited
 - Pediatric acute ischemic stroke (AIS) differs in etiology, physiology, and natural history
 - Imaging features of AIS (hyperdense vessels, early infarct signs) may be missed
 - Lack of “stroke centers” and standardization of care
 - tPA dosing, endovascular mechanical thrombolytic devices



DID YOU KNOW?

STROKE OCCURS IN TODDLERS, CHILDREN, AND TEENS. STROKE IS AN EMERGENCY AT ANY AGE!

WARNING SIGNS



IF ONE OR MORE OF THESE SIGNS ARE PRESENT, DON'T DELAY!

CALL 911 OR THE EMERGENCY SYSTEM IN YOUR COUNTRY!

ADDITIONAL WARNING SIGNS IN CHILDREN

- Severe sudden headache, especially with vomiting and sleepiness
- Sudden weakness or numbness on one side of the body (face, arm and/or leg)
- Sudden confusion, difficulty speaking or understanding others
- Sudden trouble seeing to one side or loss of vision
- Sudden difficulty walking, dizziness, loss of balance or coordination
- New-onset of seizures usually on one side of the body

IF IT LOOKS LIKE A STROKE

THINK STROKE

Signs of stroke are often missed in children and teens because there is a lack of awareness that strokes can happen in this age group.



About **HALF** of the children presenting with a stroke have a **PREVIOUSLY IDENTIFIED RISK FACTOR**

TOP 10

Stroke is one of the **TOP 10 CAUSES OF DEATH** in children



The use of tPA (a clot busting treatment) or clot retrieval devices are **NOT FDA APPROVED FOR USE IN CHILDREN** in the U.S.

MEDICAL CONDITIONS ASSOCIATED WITH STROKE INCLUDE: Sickle Cell Disease, Moyamoya Syndrome, Arterial Dissection, Autoimmune Disorders, Congenital Heart Disease, Blood Clotting Disorders

Learn more at iapediatricstroke.org and strokeassociation.org

Sources:
iapediatricstroke.org/infographic.pdf
iapediatricstroke.org/2014%20AHA_fact.pdf
heart.org/fdc/groups/heart-public/@wcm/@sop/@smd/documents/downloadable/ucm_472920.pdf



STROKE HAS NO AGE LIMITS.

It can happen to children, even infants.

Pediatric Stroke

▼ What causes ischemic stroke in children?

Identifying [pediatric stroke](#) and finding the cause of a stroke is vital to providing the right treatment and preventing more injury. Doctors can find a cause in about two-thirds of the cases. A common cause of ischemic strokes is that a blood clot forms in the heart and travels to the brain. This can be caused by [congenital heart problems](#) such as abnormal valves or infections. In these cases children may need surgery or antibiotics.

Sickle cell disease is a blood disorder that's associated with ischemic stroke. In sickle cell disease, the blood cell can't carry oxygen to the brain, and blood vessels leading to the brain may have narrowed or closed. About 10 percent of children with sickle cell disease suffer a stroke¹. There is a high risk of repeat strokes, but this can be reduced by blood transfusion.

Finally, ischemic strokes can be caused by trauma that injures large arteries and causes a loss of blood flow. For instance, a large artery might be injured when a child has a neck injury.

¹ Cooperative Study of Sickle Cell Disease

► What causes hemorrhagic stroke in children?

► Will my child get better?

► What are the effects of stroke in children?

New Pediatric Stroke Resources



Thanks to the [International Alliance for Pediatric Stroke's](#) hard work and dedication, we are excited to share new pediatric stroke resources. Help us spread pediatric stroke awareness with these new tools:

- [Pediatric Stroke Infographic](#) [English](#) | [Spanish](#)
- [Perinatal Stroke Infographic](#) [English](#) | [Spanish](#)
- [Check out Alex's Stroke Story](#)
- [Watch Rhys' Stroke Story](#)
- [Dr. Ichord Discusses the Importance of Spreading Awareness](#)

Pediatric Stroke Risk Factors

- Sickle Cell Disease
- Cardiac Disease/Congenital Heart Disease
 - Recent invasive procedure, cardiomyopathy, and arrhythmias
- Prothrombotic state
- Recent head and neck infections
- Recent viral illness
- Dehydration
- Autoimmune disorders
- Arteriopathies
- Previous stroke
- 24% are considered “idiopathic”

Pediatric Risk Factors

- Based on CA state-wide discharge database:
- Males more likely to have any type of stroke compared to females (16.8% vs 11.8%)
 - Males higher risk of mortality from ischemic stroke
- African Americans (non-sickle cell) 2x more likely than non-AA
- Hispanic children have lowest risk of stroke

Clinical Presentation

- First time seizure with post-ictal neurological deficit
- Irritability
- Symptoms subtle in younger ages
 - Use of non-dominant hand
 - Refusal to walk
 - Language acquisition to describe symptoms challenging
- “Classic Story”

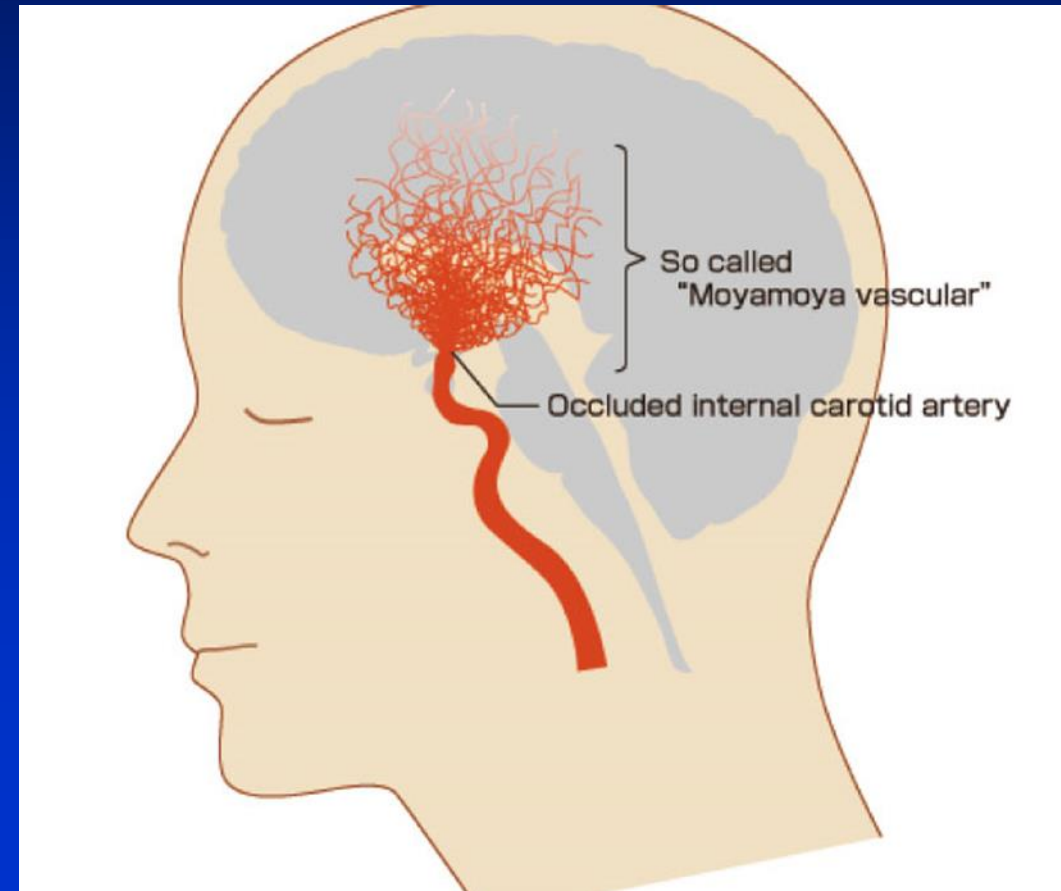
Neuroimaging in Children

- CT scan
- MRI
 - Diffusion weight imaging
- Angiogram

**need for pediatric anesthesia

Pediatric Stroke Mimickers

- Todd's paralysis- transient hemi paralysis following seizure
- Hypoglycemia
- Hemorrhagic stroke/subdural
- Traumatic injury, child abuse
- Electrolyte abnormalities
- Complex migraines
- Brain tumor
- Intracranial infection or abscesses
- Carotid dissection
- Moyamoya



Treatment Strategies

- Sickle cell disease
 - Emergent exchange transfusion
- Moyamoya
 - Supportive care
 - Revascularization surgery
- Hemorrhagic stroke
 - Neurosurgery vs supportive care
 - ?child abuse work up
- Ischemic stroke
 - ?tPA or neurointervention

Pediatric NIH Stroke Scale

Interrater Reliability of the Pediatric National Institutes of Health Stroke Scale (PedNIHSS) in a Multicenter Study

Rebecca N. Ichord, MD; Rachel Bastian, BA; Lisa Abraham, MD; Rand Askalan, MD, PhD; Susan Benedict, MD; Timothy J. Bernard, MD; Lauren Beslow, MD; Gabrielle deVeber, MD; Michael Dowling, MD, PhD, MSCS; Neil Friedman, MBChB; Heather Fullerton, MD, MAS; Lori Jordan, MD, PhD; Li Kan, MD; Adam Kirton, MD; Catherine Amlie-Lefond, MD; Daniel Licht, MD; Warren Lo, MD; Chalmer McClure, MD, PhD; Steve Pavlakis, MD; Sabrina E. Smith, MD, PhD; Marilyn Tan, MD; Scott Kasner, MD, MSCE; Abbas F. Jawad, PhD
(*Stroke*. 2011;42:613-617.)

- PedNIHSS- same elements as adult NIHSS (11 neurological domains, 15 scored items)
- For children ages 2 to 18- based on age and development
- Total score range 0-42 (most severe)
- Good IRR for “*trained pediatric neurologists*”

Thrombolysis in Pediatric Stroke Study

Michael J. Rivkin, MD; Gabrielle deVeber, MD, MHSc; Rebecca N. Ichord, MD;
Adam Kirton, MD, MSc; Anthony K. Chan, MBBS; Collin A. Hovinga, PharmD, MS;
Joan Cox Gill, MD; Aniko Szabo, PhD; Michael D. Hill, MD; Kelley Scholz, MSW;
Catherine Amlie-Lefond, MD

(Stroke. 2015;46:880-885.)

- Multi-institutional study from 2010-13 to determine safety, best dose, and feasibility of tPA in children ages 2-17
 - 3 dosing tiers of tPA (0.75, 0.9, and 1mg/kg)
- 93 children screened
 - 43/93 (46%) had acute ischemic stroke
 - 21 had medical contraindication to tPA
 - 10 outside of treatment window at final diagnosis (7+presented within 5hrs of symptom onset!!)
 - 2 lacked evidence of arterial occlusion on imaging
 - 9 excluded for low PedsNIHSS score <6
 - Only one patient met inclusion criteria for tPA
- Study closed by NIH for lack of enrollment

Emergence of Pediatric Stroke Centers

- Lessons from the TIPS study
- 17 active enrollment sites
 - Prior to TIPS protocol, <25% had 24/7 access to peds stroke team, MRI capability, or stroke order sets
 - After TIPS study, >80% have acute pediatric stroke systems in place
- Areas of difficulty
 - 24/7 pediatric sedated MRI access, institutional support, QI and CME efforts
- Created a standardization of care for pediatric stroke

Alteplase

- Recombinant tissue-type plasminogen activator
 - IV fibrinolytic- converts plasminogen to plasmin, facilitates clot breakdown
 - Children have immature fibrinolytic system
 - low baseline free-tPA
 - Elevated plasminogen activator inhibitor-1 (inhibitor of tPA)
 - Larger Vd
 - Increased hepatic clearance
 - NOT FDA APPROVED!
 - Recommended dose:
 - $\leq 100\text{kg}$: total dose 0.9mg/kg, 10% IV bolus over 5min, remainder given over 55min
 - $\geq 100\text{kg}$: total dose 90mg, 9mg IV bolus over 5 min, remainder over 55 min
 - ***may actually have higher requirement!

Candidates for intervention in children

- tPA candidates
 - ≥ 24 months
 - Last seen well <4.5 hrs from presentation
 - Confirmed clot on neuroimaging
 - PedsNIHSS >4
- Neurointerventional radiology candidates
 - ≥ 24 months
 - Last seen well >4.5 hrs but <24 hrs
 - Confirmed clot on neuroimaging
 - PedsNIHSS >4

Contraindications for tPA

- Similar to adult contraindications
 - Major stroke, head trauma, intracranial surgery in last 3mo
 - GI or urinary bleeding in last 21 days
 - Major surgery within last 10 days
 - History of prior ICH
 - Known cerebral vascular malformation
 - Coagulopathy (plts <100, INR >1.4, elevated aPTT for age)
 - HTN >15% above 95%ile for age
 - LWWH within 24hrs
 - Intracranial hemorrhage or dissection
 - Large territory stroke (>1/3 MCA distribution) or PedsNIHSS >24

Acute Management of Suspected Stroke

- Same adult principles apply!

Stroke Specific Clinical Questions

- Time child was last seen well
- Time of symptom onset
- Current aspirin, lovenox , or other anticoagulation use
- Major stroke, head trauma, or intracranial surgery in last 3 months
- GI or urinary bleeding with last 21 days
- Major surgery within last 10 days
- Past Medical History (congenital heart disease, sickle cell disease, cancer)
- NPO status

Acute Management of Suspected Stroke

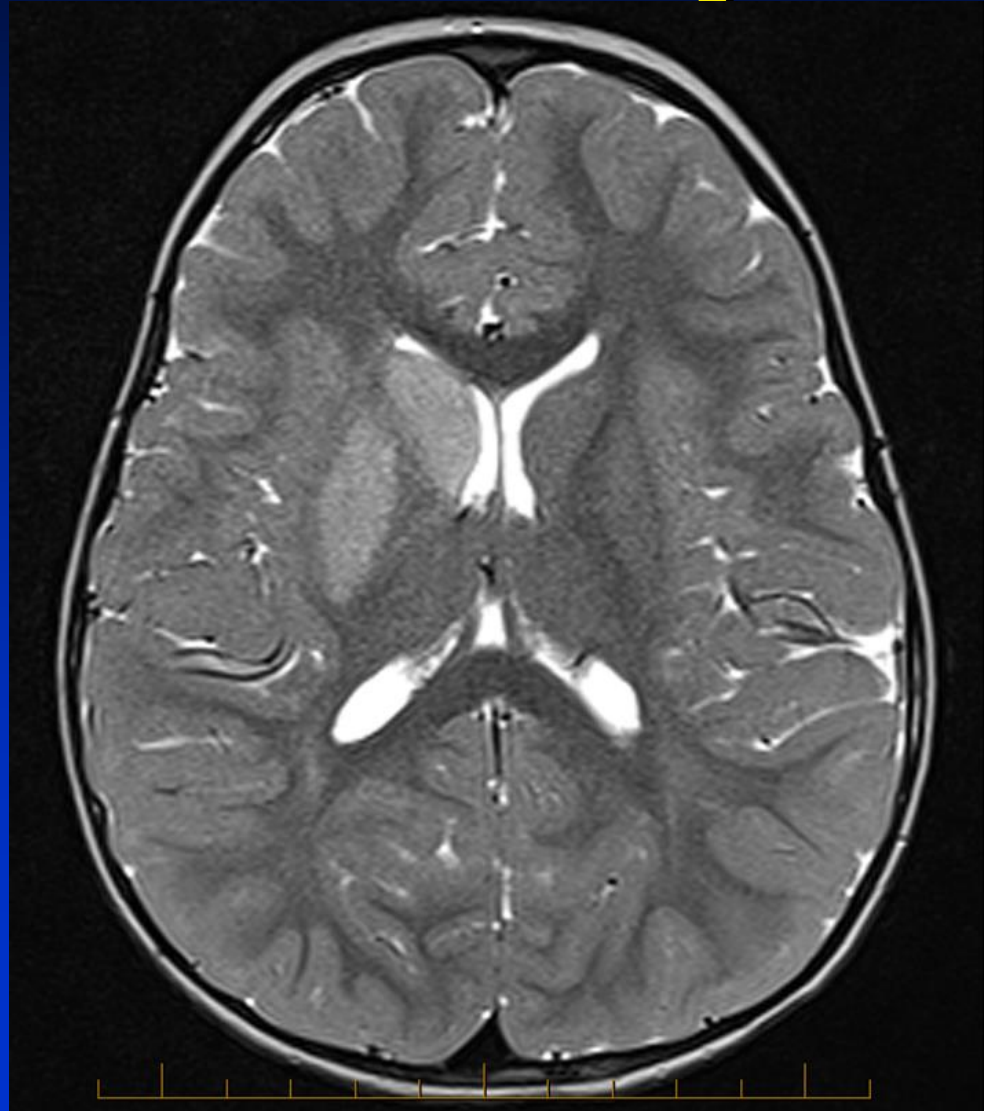
Clinical Management

- Obtain hard copy of any neuroimaging
- NPO
- Large bore IV in antecubital vein (at least 22g for small children)
- Isotonic IVF
- Avoid hypotension
- Avoid hyper/hypoglycemia
- Keep HOB flat to promote cerebral perfusion
- Evaluate at CMH Adele Hall ER

Case Study

- 2yo previously healthy male who had recently recovered from GI illness was playing soccer in back yard. He bent down to pick up soccer ball and slowly fell to his left side. Per mom, was not using his left side, left side was droopy, and he seemed to be slurring his words. When she picked him up, started drooling with a “glazed look”, became limp and unresponsive. Episode lasted 5minutes. No shaking movements. EMS was called and en route seemed sleepy and “out of it”.
- GI illness (vomiting/diarrhea), but no current symptoms
- CT head and labs in ER normal, but not back to neurological baseline, admitted to floor with suspected Todd’s paralysis after first time seizure
- Next day, more alert, but not using his left hand (attributed to IV), and slight facial droop

Case Study

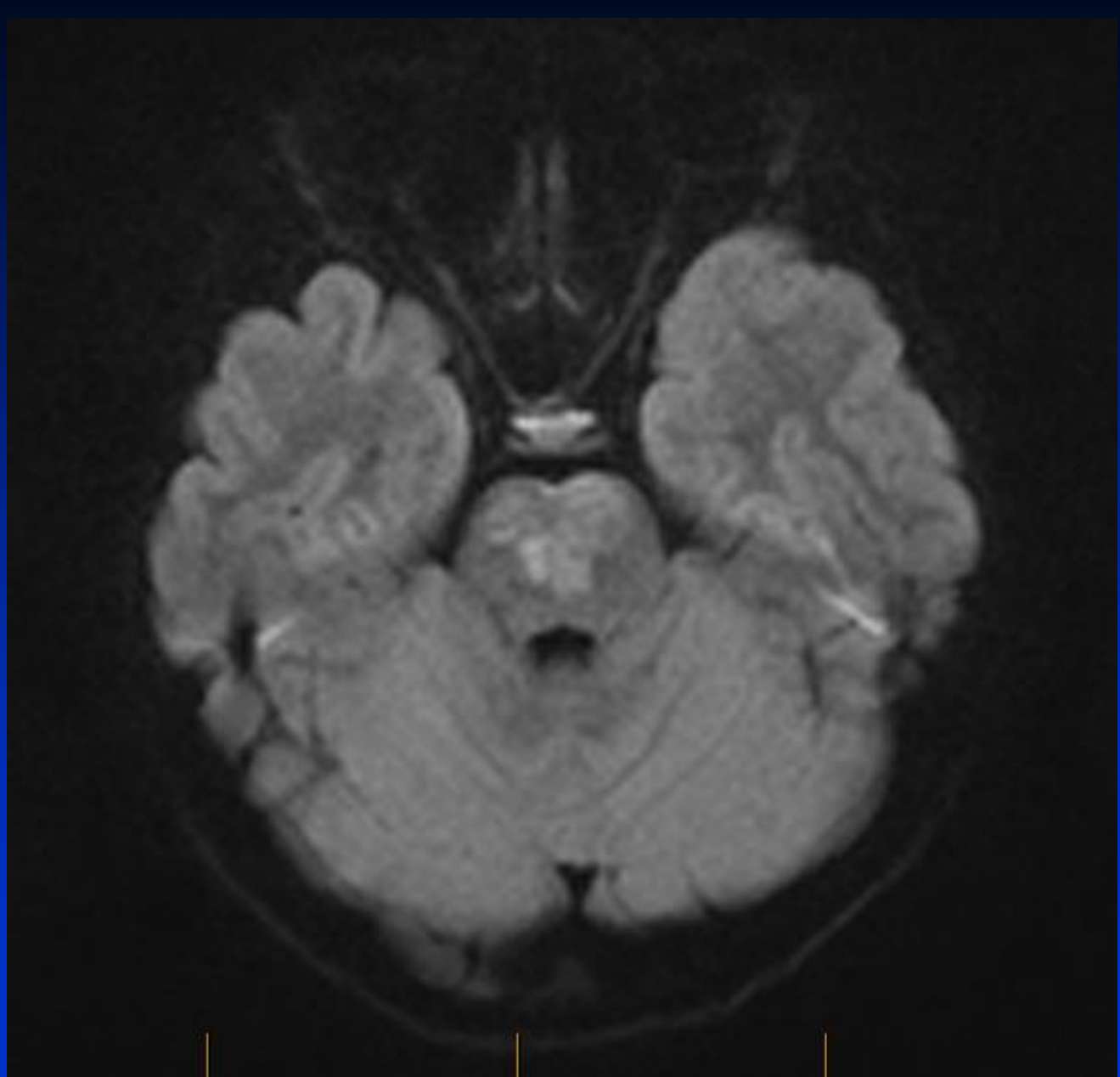


Case Study

- US/Doppler of neck
 - Cervical nodes, increased R ICA velocity
- Angiogram of neck
 - Focal stenosis of proximal right carotid ?fibromuscular dysplasia
 - Filling defect within R lateral lenticulostriate artery
- Other work up for autoimmune/connective tissue disorder negative
- ?transient cerebral arteriopathy of childhood
- Persistent L hemiplegia and speech deficit

Case Study

- 8yo previous healthy male presents to CMH Kansas ER at 11:46am with headache and slurred speech upon waking at 9am. He spent the entire previous day at the pool and family initially attributed headache to fatigue. He seemed “out of it” (inappropriately laughing/crying) when the family was out to eat for breakfast earlier that morning but was able to eat “ok”. He became incontinent on the way home. While mom was cleaning him up, she noticed he was unsteady on his feet and unable to communicate his words.
- In the ER, VSS, uncooperative with exam. He has inappropriate and slow responses to verbal commands/stimuli. Smiles and cries on and off inappropriately. Tries to speak but cannot. No facial droop but drooling intermittently.





Case Study

- MRI/MRA- basilar artery filling defect with ventral pontine stroke
- Transferred for neurointerventional consult
 - Successful clot retrieval
- DC'd home 5 days later neurologically intact
 - Remains on Lovenox

Summary for Pediatric Stroke Care

- Etiology, risk factors, and clinical presentation differ compared to adult acute ischemic stroke
- National guidelines and standardization of care are lacking
 - But progress is being made!
- Early recognition and prompt diagnosis can be challenging but are important to time-sensitive intervention
- Management concepts for suspected pediatric stroke are similar to adults
- Tertiary pediatric care facility is crucial to implement pediatric stroke care

