Pediatric Stroke

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Disclosures

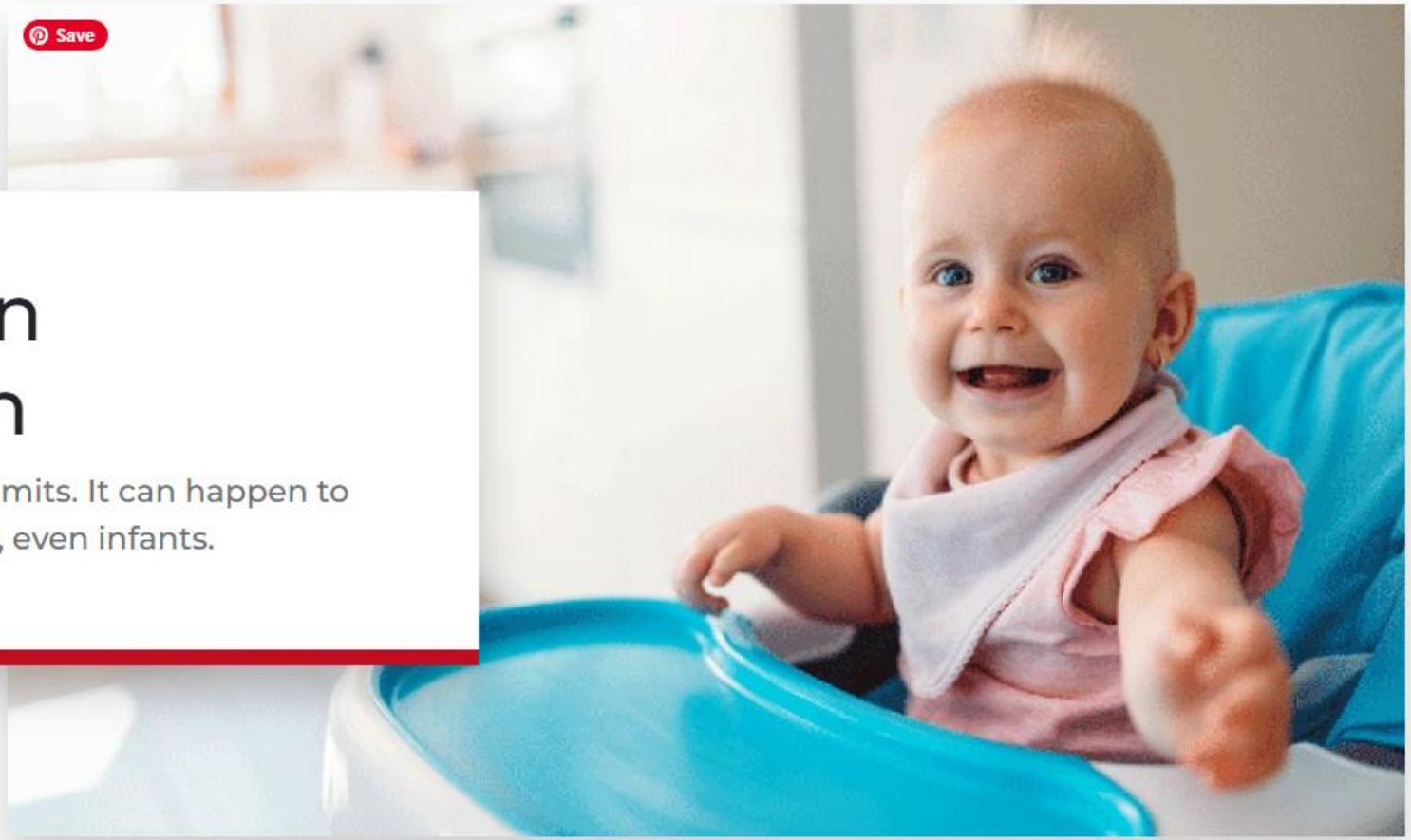
- None to report

Objectives

- Discuss care considerations for individual populations across the stroke continuum.
- Increase your awareness of pediatric stroke
- Understand how pediatric stroke differs from adult stroke in
  - Symptoms
  - Causes
  - Workup
  - Research
  - Treatment
  - Outcome

Stroke in Children

Stroke has no age limits. It can happen to teenagers, children, even infants.



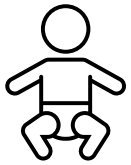
Age Grouping of Stroke

- Perinatal: 0-28 days
  - Maternal-baby factors
  - Unlikely to reoccur
  - Assess for baby risk factors
  - Evaluate mom for anti-phospholipid antibody syndrome

- Childhood 29 days to 17 years

Stroke Across the Lifespan

Babies



1 in 2,300

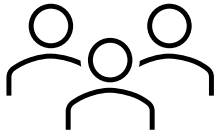
live births

Children

2-13

Per 10,000

Adults



3% of adults

have had a stroke

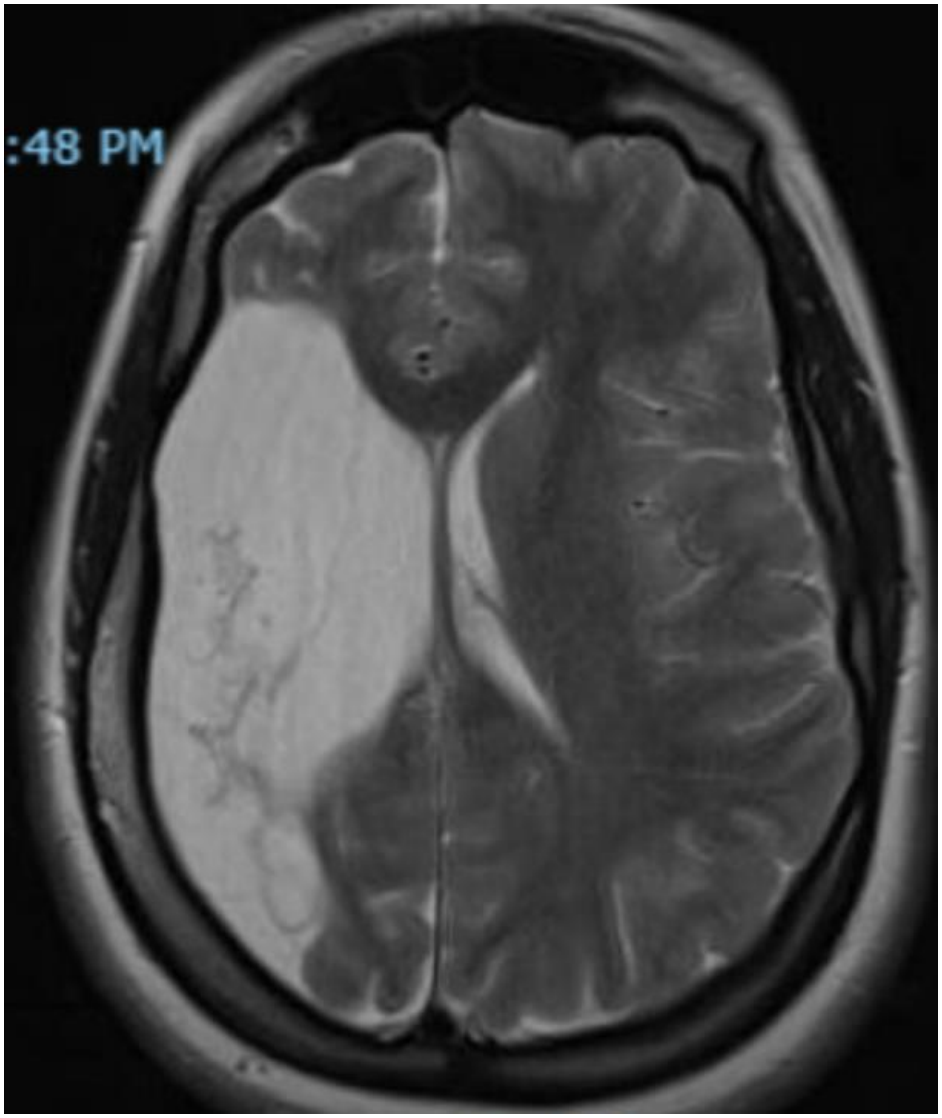
IOWA

Patient: MB

- Term birth
- Pregnancy: maternal fall, herniated disc on opioids
- Nuchal cord x 1
- Did well, home with mom
- Moving all limbs equally

Patient MB

- Concern at 4 months of age
- Only reaching for toys with one hand.
- Neuro exam with RH preference & increased tone in RUE & RLE



Perinatal Stroke: Symptoms

- What symptoms would a newborn have?
  - Most common is seizures
    - (If stroke is recent)
    - First day of life
    - Can be apnea only
    - Term infant – apnea – think stroke
- Otherwise you can't see the injury until the milestone is missed
  - (Second trimester/early third stroke)
  - Early handedness is a red flag

Childhood Stroke: Symptoms

- Hemiparesis
- Seizures in 37%
- Non-specific Symptoms (49%)
  - Headache
  - Nausea/vomiting

Step 2: Recognition

If your child has one or more of these signs, don't delay — call 911 immediately.

Warning signs in children can include:

- 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 in one or both eyes
- Sudden difficulty walking, dizziness, loss of balance or coordination
- New onset of seizures, usually on one side of the body

Prompt action and medical treatment can maximize outcomes. Remember that stroke is a potential risk for everyone.

Stroke in Children | American Stroke Association

Recognition

- **Brauen et al. Study**
- **A correct diagnosis was not obtained in 19 out of 45 pediatric ischemic stroke patients**
- ***Delay in diagnosis ranged from 15 hours to 3 months from initial presentation***

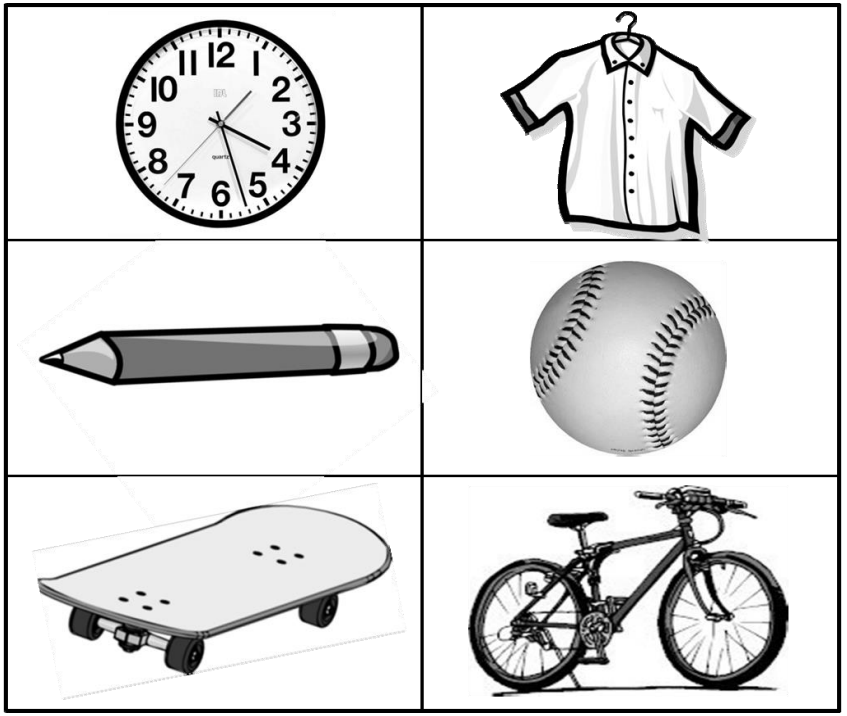
Braun KP, Kappelle LJ, Kirkham FJ, Deveber G (2006). Diagnostic pitfalls in paediatric ischaemic stroke. Dev Med Child Neurol, 48:985-90.

Delayed Diagnosis in Peds AIS

- Canadian Study
- Median interval from **symptom onset to diagnosis** of stroke was 22.7 hours.
  - –29 hours in those with out-of-hospital strokes
  - –*median time from symptom onset to hospital arrival was 1.7 hours*
  - –11.6 hours in those with in-hospital strokes
- Median time from symptom onset to neuroimaging:
  - –8.5 hours in the out-of-hospital group
  - –10.5 hours in the hospitalized group

https://www.ahajournals.org/doi/10.1161/STROKEAHA.117.016868

Pediatric NIHSS



Repetition

a. Stop
b. Stop and go
c. If it rains we play inside
d. The President lives in Washington

Reading

a. Stop
b. See the dog run
c. Little children like to play outdoors

https://www.mdcalc.com/calc/10270/pediatric-nih-stroke-scale-nihss

Etiology

Adults

- Hypertension
- Diabetes
- atherosclerosis

Children

- Cardiac disease
- Clotting disorders
- Sickle Cell
- Arteriopathy
  - Post-infection

Etiology

- > 50% have underlying arteriopathy
  - Transient (focal) arteriopathy vs
  - Other disease-specific arteriopathy
- Unknown 10-30%
  - No identifiable risk factors

Infection

- Recent viral infection is stroke risk factor
- 24% of strokes in IPSS were infection-related

- VIPS study (vascular effects of infection in pediatric stroke)
  - Odds ratio of having stroke after infection is 6.3

- Vaccines are protective against stroke

Cardiac Disease

- Congenital heart disease, esp. cyanotic
- Perioperative = highest risk time
- 40% association between AIS and cardiac surgery or cath with cardiac disease

Sickle Cell Disease

- **200 fold** greater risk of stroke
- 11% stroke prevalence by age 20
- Up to 1/3 have “silent” strokes → cognitive deficits
- Can develop moyamoya syndrome

Sickle Cell Disease

- 40% stroke w/i 3yrs if TCD ≥ 200cm/s
- STOP Trial: chronic transfusions reduce primary stroke risk by 92%
  - Possibly by halting progression to lg vessel arteriopathy
- SwiTCH trial was halted early (2° prevention)
  - Attempt to transition to hydroxyurea
  - 10% had stroke recurrence vs 0% in transfusion group

Cancer

- 2006 Childhood Cancer Survivor Study
  - Risk of stroke compared to sibs
  - 6 fold risk in leukemia
  - 30 fold risk in brain tumors
- Craniocervical radiation:
  - 2% @5yrs and 4% at 10yrs

Miscellaneous Risk Factors

- Iron deficiency anemia
  - 20% of healthy children with AIS

Workup / Imaging

- MRI brain is preferred
  - Rule out stroke mimics
  - No radiation
- Limited MRI can avoid sedation
- Perfusion imaging is tricky
  - Cerebral blood flow norms change throughout childhood
  - Not "adult-like" until after age 10

Not just "little adults"

- Cerebral hemodynamics differ
- Brains of children < 8 y.o. are more metabolically active
- *A 5-year old's brain uses up to 200% more glucose than an adults' brain.*
- The increased blood flow demand makes them more at risk for injury during hypoglycemia.

Hollist M, Au K, Morgan L, Shetty PA, Rane R, Hollist A, Amaniampong A, Kirmani BF. Pediatric Stroke: Overview and Recent Updates. Aging Dis. 2021 Jul 1;12(4):1043-1055. doi: 10.14336/AD.2021.0219. PMID: 34221548; PMCID: PMC8219494.

Research is limited...

- International Pediatric Stroke Study
  - > 100 centers in 34 countries
  - > 8,000 children with stroke enrolled
  - University of Iowa is a participating site
- Most recommendations are “expert opinion” and consensus-based.
- In general, adult hyperacute treatments can be utilized

Recovery

- Better or Worse?
- “Kennard principle” : assumption that young brains recover better.
- "selective vulnerability": what happens when injury prevents a developing brain from forming normally?

What is Recovery?

- "True Recovery":
  - a return to normal patterns of motor control
  - Physical repair of neural networks
- "Compensation"
  - Finding new ways to accomplish tasks
  - Neural learning & adaptation

- Critical window: the brain increases proteins --> brain remodeling for a limited time after stroke.

Recovery

- In adults, sensation & movement improve most in the first 3 months, and language and cognition continue to get better.

- Preschool – school aged children showed continued recovery in gross motor skills in the first year after stroke
  - Motor stabilizes between 6-12 months post stroke.

Outcomes

- 2-20% mortality for acute ischemic stroke
- Increased mortality in
  - Male
  - African American
  - Stroke recurrence

- ~ 1/3 develop epilepsy within 10 yrs

Pediatric Stroke Disability

- 2/3 have neurologic deficits
- 1/3 have moderate to severe disability
- Younger age have worse neurocognitive outcomes

- PSOM: Pediatric Stroke Outcome Measure
  - validated measure of outcome
  - 5 domains of neurologic function

Mental Health Outcomes

- At 10 years out, over 25% reported mental illness
- Compared to only 5% of age-matched peers

Stroke Recurrence

- Only 1.2% in *perinatal* stroke

Stroke Recurrence

- **>1 in 10 children will have another stroke within a year of their initial stroke**
- **Cumulative rate:**
  - **6.8% at 1 month**
  - **12% at 1 year**
- **Before the use of antithrombotic treatment, recurrence rates were as high as 30% to 50%**

https://www.ahajournals.org/doi/epub/10.1161/STR.0000000000000183

Patient MB

- No stroke reocurrence
- Left-sided Hemiplegic Cerebral Palsy
  - Ambulatory (hemiplegic gait)
  - Discussing surgery for foot deformity
  - Leg/hip pain
  - Minimal use of L arm
- Mild intellectual disability
- Anxiety & Depression
- Epilepsy since age 5
  - on 2 medications, not controlled

Questions?

Resources

- Pediatric Stroke Awareness - CHASA
- Stroke in Children | American Stroke Association

References

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