Neurological Perspectives on Pediatric Hypoxic Brain Injury

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Case 1

- Baby born at 35 weeks gestation (full term 40 weeks)
- Placenta allowed fetus’ blood cells to enter the mother’s blood stream (fetomaternal transfusion)
- Baby born with dangerously low amount of blood but has blood transfusion within 4 hours of birth when the problem is discovered.
Case 2

- Patient born at 38 weeks gestation and initially appears healthy
- At 12 hours of life begins to have trouble breathing, starts turning blue, and oxygen level in blood found to be low.
- Found to have malformation of heart causing blood to bypass the lungs.
- Undergoes multiple surgeries and procedures with stabilization but average oxygen level is 75% of what it should be for the first 2 years of life until final surgery is performed.
Case 3

- Typically developing 4 year old child falls into swimming pool and is underwater for 3 minutes before rescued.
- CPR started with rapid return of independent breathing and heart rate
- Child is awake and crying by the time that emergency medical personnel arrives.
- Observed overnight in the hospital and released the following day with no apparent neurological deficits
Case 4

- Baby is born at 36 weeks gestation with no apparent complications of pregnancy, labor, or delivery.
- Child is taken to pediatrician for 6 month well child check and is hitting expected developmental milestones.
- At 9 months of age, child reaches for objects almost exclusively with his left hand and has not yet started attempting to crawl.
What is a Hypoxic Brain Injury?

- Hypoxic = low oxygen
- Dysfunction of brain cells from a decrease in oxygen supply
  - Decreased blood flow / blood clot
  - Decreased oxygen in blood
  - Decreased amount of blood in body
How Does This Happen?

- **Examples:**
  - **Prenatal:**
    - decreased blood flow from placenta
    - umbilical cord compression
  - **Infancy / Early Childhood:**
    - prematurity
    - congenital heart disease / lung disease
    - trauma
    - stroke
How is the Brain Affected?

- **Focal injury**
  - Only part of the brain involved
    - stroke
    - Child abuse
    - Trauma / accidents

- **Diffuse Injury**
  - Affects entire brain at once
    - Low oxygen level in blood (heart or lung disorder)
    - Loss of blood flow to baby during delivery
    - Near drowning
Timing of Injury

- **Acute**
  - Cause is typically apparent
  - Short period of profound drop in oxygen

- **Chronic**
  - More insidious onset
  - Hours to years
  - Chronically low oxygen in blood due to other medical condition
Early Signs of Hypoxic Brain Injury

- **Focal (only part of brain involved)**
  - Stroke like symptoms
  - Seizures
  - May or may not be immediately apparent, depending on age and ongoing medical problems

- **Diffuse (large part of brain at once)**
  - Decreased level of consciousness
  - Seizures
  - If mild, may have no signs at time of insult
Late Signs of Hypoxic Brain Injury

- Failure to meet expected developmental milestones (adjusted for gestational age and medical complications)
- Cerebral Palsy
- School failure
- Specific learning disabilities
- Disorders of attention and concentration
- Problems with socialization or peer relationships
- Epilepsy
“Developmental Delay”

- Phrase used in early stages of development (typically < 6 years old)
- Behind in meeting expected milestones
  - Crawl – 12 months
  - Walk – 18 months
  - Speak – 24 months
- Adjusted for prematurity and significant medical illnesses
- Speech, gross/fine motor, emotional, global
- Potential for improvement / “catch up”
Developmental Disability

- Typically apparent by 5-6 years of age
- Permanent “developmental delay”
- Characterized by type of disability
  - Intellectual / cognitive
  - Motor
  - Speech
  - Global
Person vs Disability

- Personality
- Interpersonal relationships
- Ultimate productivity / life choices
- Cognitive disabilities often harder to predict than physical
Evaluation

- Routine screening
  - Well child check
  - Ongoing specialist care
- If concern is raised, additional consultation with:
  - Developmental Pediatrician
  - Pediatric Neurologist
  - Pediatric Psychologist / Neuropsychologist
Neurological Evaluation

- Physical examination
- Caregiver history
  - Slow progress
  - Plateau
  - Regression
- Supplemental testing
  - MRI - structure
  - EEG - function
  - Neuropsychological testing
  - PT/ST/OT evaluations
Neuroplasticity

- Brain has ability to change and “rewire”
- Best chance up until age 5
- Can be demonstrated using fMRI technology
- Early recognition and intervention
- Makes early prediction of long term outcome very difficult in young children
Long Term Management

- Neuropsychological / Psychoeducational Testing
- Therapy services
- Early integration into school programs
- Appropriate physical activity
- Individualized Education Plan
- Family / Caregiver support
Pitfalls

- Symptoms often not apparent at time of injury
- Other complex medical problems may mask symptoms
- Primary medical specialists likely focusing on different problems
- Be wary of people who are telling you the future
Resources in Oklahoma

- Sooner Start (birth – age 3)
- Early education services (age 3 – school age)
- Special education services
- TEFRA program
Understanding The Disability

- Ask a lot of questions
- The answer may be “I don’t know”
- Look at the pictures
- One day at a time
- Nurture your child’s strengths
- Open line of communication between providers (to include medical providers, teachers, therapists, specialists)
Revisiting our cases
Case 1

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- Placenta allowed fetus’ blood cells to enter the mother’s blood stream (fetomaternal transfusion)
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Follow Up

- Seen by neurologist every 6 months after discharge from NICU
- By 2 years of age, walking well and saying 50 words, no abnormalities on examination
- At age 3 admitted to hospital for prolonged seizure, diagnosed with epilepsy
Case 2

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- At 12 hours of life begins to have trouble breathing, starts turning blue, and oxygen level in blood found to be low.
- Found to have malformation of heart causing blood to bypass the lungs
- Undergoes multiple surgeries and procedures with stabilization but average oxygen level is 75% of what it should be for the first 2 years of life until final surgery is performed.
Follow Up

- Mild to moderate developmental delays in the first 3 years noted by pediatrician but thought to be secondary to multiple medical procedures and hospitalizations.
- At age 4, struggling with retention of information in PreK and neuropsychological testing recommended before starting Kindergarten.
- Testing reveals low IQ and impaired processing speed, memory, and attention.
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- CPR started with rapid return of independent breathing and heart rate
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Follow Up

- Family notices subtle differences in personality and emotional control within 6 months of accident.
- Starts kindergarten at age 5 and academically keeps pace with her peers.
- By 3rd grade is starting to fall behind and struggles with higher learning concepts and application of knowledge requiring 2 hours per day of special education.
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Follow Up

- Astute pediatrician picks up on early hand dominance and refers to neurology for evaluation
- MRI reveals likely prenatal stroke involving left side of brain
- Early intervention with PT/OT initiated, developmental milestones hit within 3 months of expected target.
- At age 5, is academically at the top of his kindergarten class but still struggles with dexterity of right hand and slightly drags right foot when he walks.
Take Home Points

- Pediatric hypoxic brain injuries can be fairly subtle and may or may not have a specific identifiable cause.
- Early identification and intervention is key.
- It is nearly impossible to predict any given child’s ultimate outcome based on early evaluation and testing.
- For children with complex medical issues, the primary specialist is likely not focused on the brain and potential long term developmental sequelae.
- Children will look to adults to determine how to deal with their disability. Set the right example and expectations!
QUESTIONS???