CLINICAL SCENARIO

- Newborn term baby
- Depressed at birth (low Apgar scores)
- Overt neurological neonatal syndrome
- Evidence of fetal heart rate abnormalities
- Subsequent neuroimaging shows early cerebral edema followed by organic brain injury
- Child goes on to develop seizures, cerebral palsy, cognitive delays, impaired development
CAUSATION

• What is the cause of the brain injury
• Is there a connection between intrapartum events and neonatal injury
• Could different intrapartum management have mitigated or avoided the outcome
• Did the intrapartum care fall below acceptable standards
TERMINOLOGY

• Asphyxia
  • Hypoxia-ischemia
  • Neonatal encephalopathy (NE)
    • Describes depressed neonate without attributing a cause
    • Subset is Hypoxic-Ischemic Encephalopathy (HIE)
• Cerebral Palsy
  • Motor and cognitive dysfunction
  • Non-progressive neurological condition that includes motor dysfunction
  • Non-motor developmental compromise
  • Can it be due to intrapartum hypoxia-ischemia?
CHALLENGES TO MEDICAL CAUSATION

• Medical reason for brain injury

• Timing of brain injury
MEDICAL REASON FOR BRAIN INJURY

• Idiopathic causes
• Antenatal causes
  • Metabolic
  • Genetic
  • Infectious
• Intrapartum causes
  • Hypoxia ischemia
TIMING OF BRAIN INJURY

• Timing of injury
  • Antepartum and post-partum
  • If not intrapartum then before or after delivery
• Intrapartum
  • How do you know
  • What are the clinical indicators of intrapartum insult
  • What is the difference between insult and injury
• Comorbid causes
  • Antepartum events creating vulnerability
  • Neonatal events contributing to harm
    • Recognizing the potential for injury
    • High risk pregnancies (poor fetal growth)
    • Meconium aspiration and complications
  • Neuroimaging and timing
    • Crucial to timing
    • Imprecise (48 hour window)
      • But can help rule in/out antepartum causes
CLINICAL EVIDENCE AFFECTING TIMING

- Essential Criteria
  - According to reliable neurological opinion
  - According to obstetrical organizations (SOGC, ACOG, etc)
ESSENTIAL CRITERIA (NEUROLOGY)

• Criteria that suggests, but does not prove, an intrapartum cause for brain injury
  • Evidence of fetal distress
  • Depression at Birth
  • An overt neonatal neurological syndrome in the first hours and days of life.
• Often the above criteria are accompanied by systemic abnormalities, including:
  • Multi-organ involvement
  • Metabolic acidosis
  • Seizures
• The presence of any of these does not rule out antepartum or neonatal contributors to an adverse outcome

1 Taken from Volpe JJ, Neurology of the Newborn (5th ed) page 401.
“ESSENTIAL” CRITERIA
(OSTETRICAL COMMUNITY – ACOG)

Essential

- Evidence of a metabolic acidosis in intrapartum fetal umbilical arterial cord or very early neonatal blood samples (pH<7.0, Base deficit ≥ 12 mmol/L);
- Early onset or severe or moderate neonatal encephalopathy in infants ≥ 34 weeks gestation;
- Cerebral palsy of the spastic quadriplegic type or dyskinetic type
- Exclusion of other identifiable etiologies such as trauma, coagulation disorders, infectious conditions or genetic disorders.
Suggestive:

- A sentinel (signal) hypoxic event occurring immediately before or during labour;
- A sudden and sustained fetal bradycardia or the absence of fetal heart rate variability in the presence of persistent, late or variable decelerations, usually after a hypoxic sentinel event when the pattern was previously normal;
- Apgar scores of 0-3 for longer than 5 minutes;
- Early evidence of multisystem involvement within 72 hours of birth
- Early imaging evidence of acute nonfocal abnormalities.
METABOLIC ACIDOSIS

- Fetal asphyxia is a condition of impaired gas exchange which, if it persists, leads to progressive hypoxemia and hypercapnia with a pronounced metabolic acidosis.
- The threshold of metabolic acidosis associated with moderate to severe newborn complications is $\geq 12 \text{ mmol/L}$
- With progression of acidosis ($\geq 16 \text{ mmol/L}$) comes increasing complications
- Not all neonates with metabolic acidosis above threshold suffer injury;
  - Due to fetal compensatory response to hypoxia
  - Centralization of fetal circulation

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SUMMARY OF TIMING ISSUES

- Maternal and antenatal history (i.e. fetal movement)
- FHR tracing
- Newborn condition (NE, APGARS, etc.)
- Placental pathology
- Cord blood gases (arterial and venous)
- Neonatal arterial blood gases
- Seizure onset
- NRBC, platelet, lymphocytes
- Neuroimaging
- Neonatal health (other organs than brain)
MECHANISM OF HYPOXIA-ISCHEMIA

1. ACUTE TOTAL OR NEAR TOTAL ASPHYXIA
   - Uterine rupture, abruption, hemorrhage
   - Time to injury depends on tolerance
2. PROLONGED PARTIAL ASPHYXIA
   - Occurs over hours
   - Extent of injury depends on severity and duration
TIMING

ACUTE TOTAL ASPHYXIA

• RATE OF CHANGE OF BASE DEFICIT
  • Some controversy
  • Based on animal studies
  • May be important
  • 1 to 2 mmol/L per minute?

PROLONGED PARTIAL

• RATE OF CHANGE
  • Highly dependent on intrauterine environment
  • Can you tell from tracing?
  • What does arterial cord gas tell us regarding timing?
  • What about in utero resuscitation?
CEREBRAL PALSY AS AN ESSENTIAL CRITERIA

• ACOG states:
  • “…absent cerebral palsy, neither epilepsy, mental retardation, nor attention deficit disorder are caused by birth asphyxia.

  It is clear, however, that neurologic damage, such as isolated mental retardation, attention deficit disorder, or seizure disorder, cannot be attributed to birth asphyxia in the absence of newborn encephalopathy

• Can brain injury without motor dysfunction (not CP) be due to intrapartum events?
  • Short answer: yes
  • Studies relied on to say CP essential populated by cohort of patients with CP
  • Recent research demonstrates cognitive and developmental delays in the absence of motor involvement.
  • NE is needed for causation, but CP is not
THE DIFFERENTIAL DIAGNOSIS

• Evidence of NE
• Neonatal syndrome (i.e., seizures)
• Fetal heart rate changes suggestive of hypoxia
  • Decelerations
  • Reduced variability
  • Tachycardia and/or bradycardia
• Other intrapartum complications
  • Tachysystole
  • Meconium-stained fluid
• Neuroimaging
  • Early cerebral edema
  • Resolution of edema followed by necrosis
• Absence of intrauterine infection; IUGR; bleeding; coagulation disorders; congenital or metabolic disorders, etc
EVIDENCE NEEDED TO ESTABLISH CAUSATION

• Antenatal records (including ultrasounds, biophysical profiles, other testing)
• Information about maternal health (i.e., hypertension, diabetes, etc)
• Anecdotal evidence about late 3rd trimester fetal activity
• Intrapartum data, with emphasis on:
  • Duration of labour
  • Progress of labour
  • Fetal heart tracings
  • Maternal fever
  • Uterine contraction pattern
- Neonatal data
  - Depression (Apgar scores)
  - Seizure activity
  - Multiorgan involvement (particularly cardiac, renal and liver)
  - Arterial cord gas data
  - Neuroimaging
  - Testing for other etiologies
- Placental Pathology
  - Chorioamnionitis
  - Funisitis
- Consider Comorbidities
EXPERTS

• Obstetrics
• Neonatology
• Neurology
• Neuroradiology
• Placental Pathologist
• Geneticist
• Obstetrical Nurse
ROLE OF COUNSEL

- Know the medicine
- Ensure experts are current on the medicine
- Have a complete familiarity with the hospital records and imaging studies
- Prepare timelines, chronologies, graphs, etc
- Do not accept the opinion without challenging the expert on the important issues
- Make sure the expert knows about legal causation
- Coordinate the findings of all experts
- Drop the cases without merit
- Vigorously pursue the cases with merit
- Be prepared for a lengthy and expensive battle