HYPOXIC ISCHEMIC ENCEPHALOPATHY

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WHAT IS NEONATAL ENCEPHALOPATHY (NE)?

Occurs when the brain is deprived of oxygen – brain cells are injured, some die

- Hypoxic ischemic encephalopathy (HIE) is the cause of ~ 80% of the cases of NE

Other causes of NE include:

- Perinatal infections
- Genetic abnormalities
- Placental abnormalities
- Metabolic disorders
- Coagulopathies
- Neonatal vascular stroke

HYPOXIC ISCHEMIC ENCEPHALOPATHY

Can occur before birth, during birth, or after birth

First Stage – primary energy failure

- **Primary energy failure that triggers a cascade of events**
  - **Decreased cerebral blood flow – decreased oxygen and glucose substrates, decreased ATP production, increase in lactate levels**
  - **If the cascade is allowed to continue, altered cell membranes, impaired cellular integrity, and cellular apoptosis and necrosis occur**

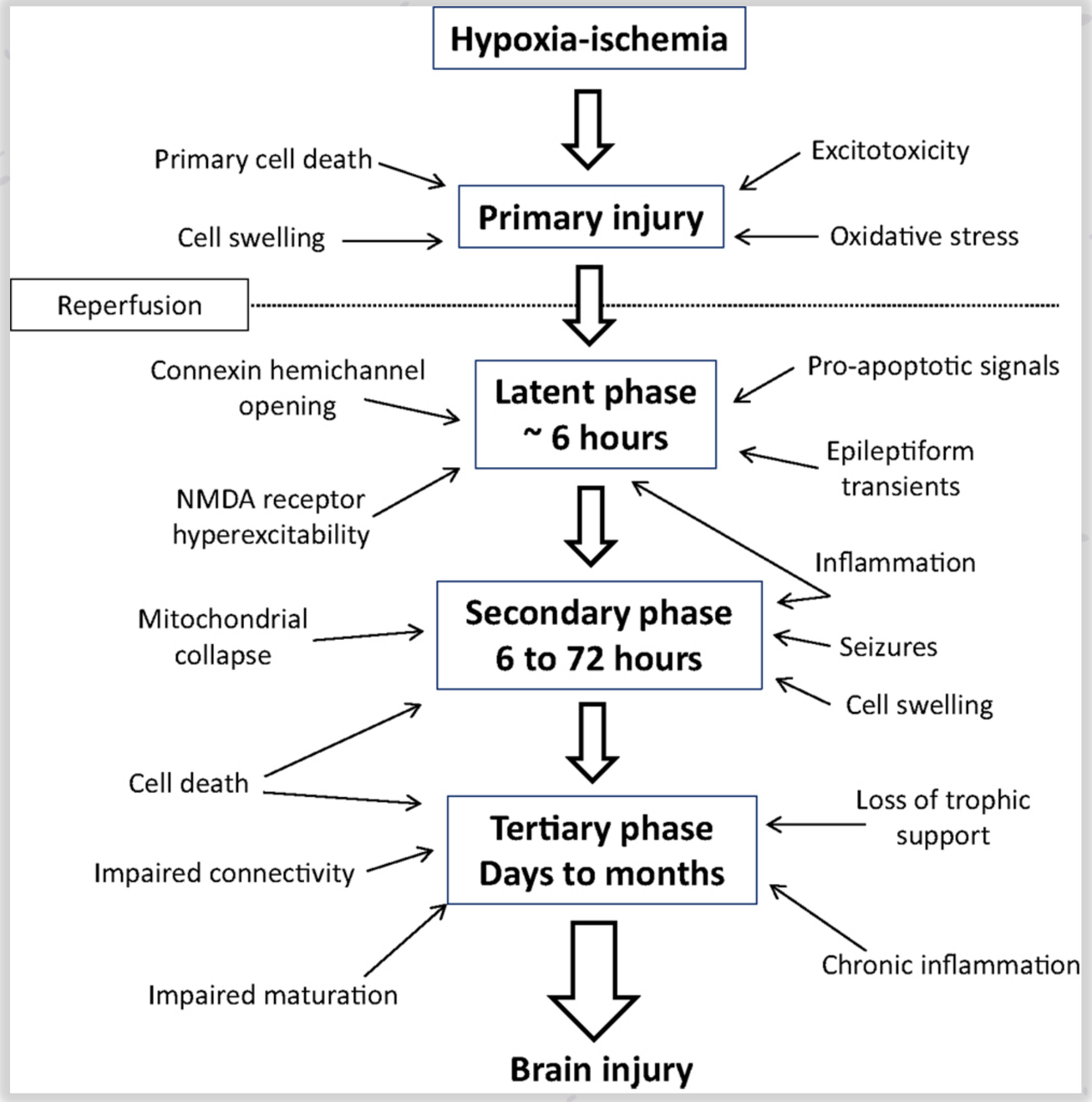
Therapeutic window

- **Period of time (usually 6 hours) between the first and second energy failures**

HIE, CONTINUED

Second stage – secondary energy failure

- Lack of energy stores and inflammation lead to brain apoptosis and necrosis over the next few days to weeks


Hypoxia-ischemia
Primary cell death
Excitotoxicity
Primary injury
Cell swelling
Oxidative stress
Reperfusion
Connexin hemichannel opening
Pro-apoptotic signals
Latent phase ~ 6 hours
Epileptiform transients
NMDA receptor hyperexcitability
Inflammation
Mitochondrial collapse
Secondary phase 6 to 72 hours
Seizures
Cell swelling
Cell death
Loss of trophic support
Tertiary phase Days to months
Impaired connectivity
Chronic inflammation
Impaired maturation
Brain injury

INCIDENCE

- 1.5 per 1000 live births in developed countries (2-4% of term infants)
  - ~ 0.3 per 1000 live births will have significant neurologic sequelae
- Up to 26 per 1000 live births in low-resource countries
- Perinatal asphyxia is estimated to account for ~ 23% of infant deaths worldwide

- In Tennessee - ~80,000 births per year
  - ~ 160 babies with HIE

POTENTIAL CAUSES OF HIE

- Umbilical Cord
- Maternal-Fetal Hemorrhage
- Placental Issues
- Uterine Rupture / Other Uterine Causes
- Labor Delivery
- Clotting Abnormalities
- Post –Birth
- Cardiac Arrest / Near SUID
- Lifestyle Choices

INITIALLY .....

- Risk factors – increased level of suspicion when risk factors present
- Respiratory depression – requiring PPV / intubation
- Hypotonia
- Apgar score of ≤ 3 at 5 minutes of age
- Metabolic Acidosis
- Neurologic signs

IMMEDIATE CARE AND EVALUATION

- ABCD
- Recognition – critical skill since we want to work within the therapeutic window
- Sarnat examination – at ~ 1 hour of age and then hourly until 6 hours of age
- Call the transport team – discuss the case with the neonatologist to get their expert opinion
- Careful attention to glucose levels, 0_2 & CO_2 levels, and blood pressure

CRITERIA FOR THERAPEUTIC HYPOTHERMIA

Apgar score of < 5 at 10 minutes of age

Continued need for resuscitation at 10 minutes of life

Acidosis defined as an umbilical pH or any arterial pH of < 7 or a base deficit of >16 in the first hour of life

One of the following: hypotonia, abnormal reflexes, weak or absent suck, or clinical seizures

Sarnat score of at least 3 of the 6 categories identified as either moderate or severe at any point in the first 6 hours of age

Table 1. Sarnat and Sarnat[4] classification of HIE

	Stage 1	Stage 2	Stage 3
Level of consciousness	Hyperalert	Lethargic or obtunded	Stuporous
Neuromuscular control			
Muscle tone	Normal	Mild hypotonia	Flaccid
Posture	Mild distal flexion	Strong distal flexion	Intermittent decerebration
Stretch reflexes	Overactive	Overactive	Decreased or absent
Segmental myoclonus	Present	Present	Absent
Complex reflexes			
Suck	Weak	Weak or absent	Absent
Moro	Strong; low threshold	Weak; incomplete; high threshold	Absent
Oculovestibular	Normal	Overactive	Weak or absent
Tonic neck	Slight	Strong	Absent
Autonomic function	Generalised sympathetic	Generalised parasympathetic	Both systems depressed
Pupils	Mydriasis	Miosis	Variable; often unequal; poor light reflex
Heart rate	Tachycardia	Bradycardia	Variable
Bronchial and salivary secretions	Sparse	Profuse	Variable
Gastrointestinal motility	Normal or decreased	Increased; diarrhoea	Variable
Seizures	None	Common; focal or multifocal	Uncommon (excluding decerebration)


In 1999
Anna Bagenholm survived one of the lowest body temperatures ever recorded at 56.7 F (13.7 C). She had been skiing when she fell through a frozen stream and became stuck for 80 minutes. Despite being clinically dead, she made a full recovery and started working at the same hospital that saved her life.

THERAPEUTIC HYPOTHERMIA

Only Evidence-Based Therapy for HIE

For the Best Results:

- Identify these babies quickly - TIME IS BRAIN
- Initiate TH within 6 hours of suspected hypoxic insult
- TH center may request that you begin passive cooling

IMPORTANT TO REMEMBER….

Avoid	Avoid
Hyperthermia - monitor temperature closely	Hypoglycemia - monitor glucose frequently and treat aggressively

ThermaKid

LONG TERM OUTCOMES

HIE can result in a wide variety of disorders including:

- Hearing loss
- Learning disability
- Mild or severe motor dysfunction
- Cerebral palsy
- Death

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