



Perinatal Webinar:

HIE

(Hypoxic Ischemic Encephalopathy)

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Disclosure:

“Please note that this Power Point presentation is an educational tool that is general in nature. It is not intended to be an exhaustive review of the subject matter or the opinion of Palmetto Health. Materials presented in this presentation should not be considered a substitute for actual statutory or regulatory language. Always refer to your legal counsel and the current edition of a referenced statute, code and/or regulation for precise language.”



Objectives

- The participant will be able to
 - recognize the criteria used when diagnosing an infant with hypoxic ischemic encephalopathy
 - recognize clinical grading system used for diagnosing the severity of hypoxic ischemic encephalopathy
 - have an increased understanding of management and treatment of the infant with hypoxic ischemic encephalopathy with therapeutic neuroprotective hypothermia



Definitions

- Birth Injury
 - Fetal or neonatal injury has occurred during the process of birth. Occurs during the first and second stages of labor
 - Examples of injury
 - Brachial plexus injury
 - Fracture clavicle
 - Damage to facial nerve
- Birth Asphyxia
 - Occurs during the first and second stages of labor when the fetus was otherwise normal
- Perinatal Asphyxia
 - Asphyxia occurred at any time in the perinatal period. From conception through the first month of life



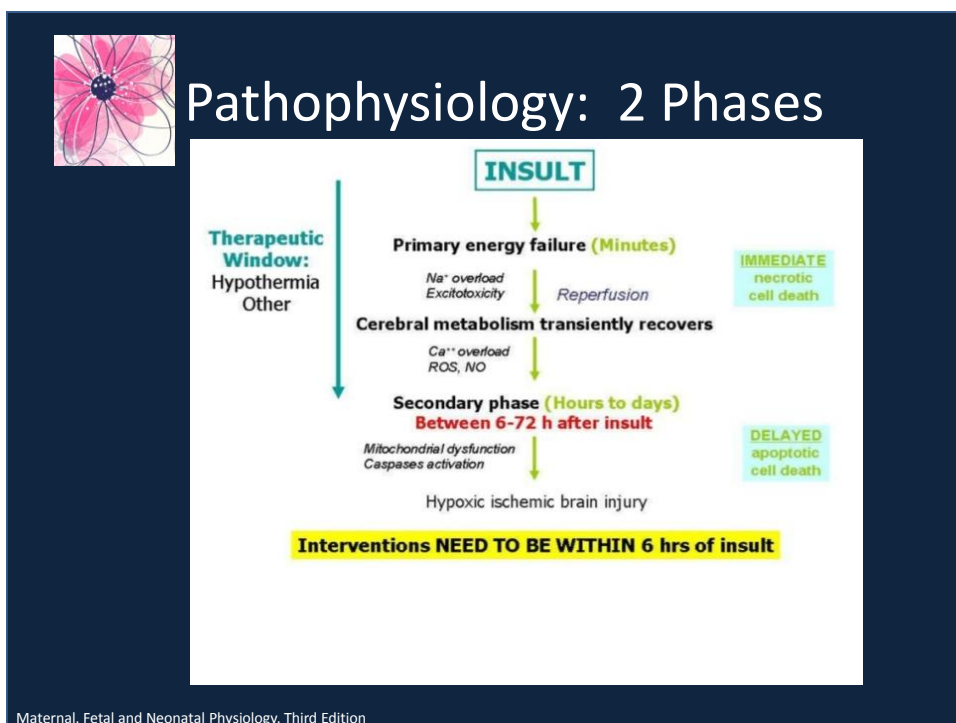
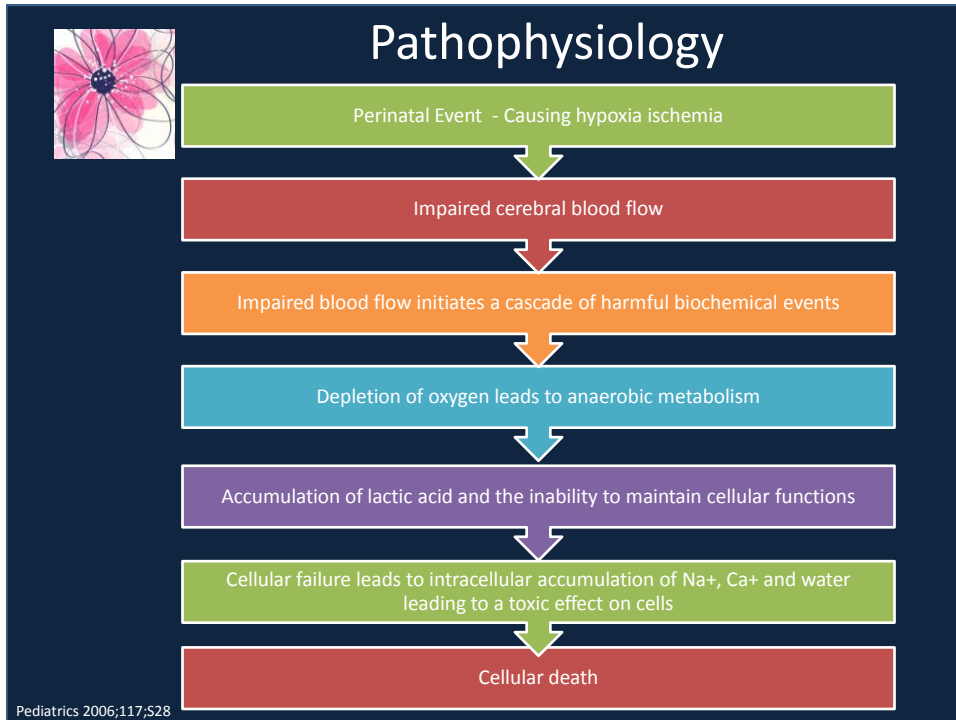
Proper Terminology

- Hypoxic-Ischemic Encephalopathy
 - Term recommend by the AAP and ACOG
 - Term accurately describes the clinical condition
 - Encephalopathy from asphyxia
 - Does not imply the time of brain injury
 - Characterized by clinical and laboratory evidence of acute or subacute brain injury from asphyxia



Incidence of HIE

- Major cause of death and disabilities
- Occurs 1-3/1000 births
- Mortality rates 10-60%
- Morbidity 25%
- 15-28% incidence of cerebral palsy



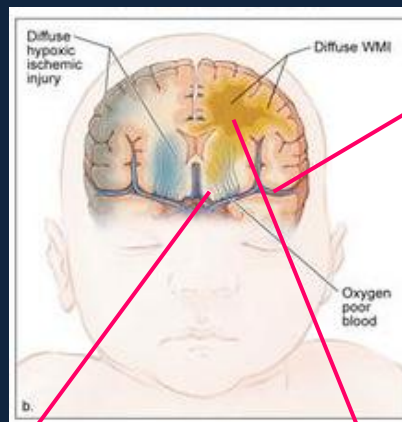


Acute Perinatal Events

- Impaired Placental and Fetal Perfusion
- Causes
 - Placental abruption
 - Uterine rupture
 - Prolapsed or ruptured cord
 - Maternal collapse requiring CPR



Hypoxic Ischemic Encephalopathy



Perinatal event
disrupts brain
perfusion

Striate vessels
underperfused

Diffuse white
matter injury



Criteria For Neonatal Therapeutic Hypothermia

- Candidates For Whole Body Cooling
 - Gestational age ≥ 36 weeks
 - ≤ 6 hours of age
 - pH ≤ 7.00 or base deficit ≥ 16 mmol/L in an umbilical cord blood sample
or any blood sample obtained within the first hour after birth
 - Moderate or severe encephalopathy on clinical examination
 - Acute Perinatal event
 - Assisted ventilation at birth and continued for 10 minutes
 - APGAR score ≤ 5 at 10 minutes after birth

<http://pediatrics.aappublications.org/content/133/6/1146/T1.expansion.html>



Clinical Staging of HIE – Sarnat Grading Scale of HIE

(Sarnat and Sarnat, 1976)

Mild HIE- Sarnat Stage I

- Hyper-alert
- Eyes wide open
- Does not sleep
- Irritable
- No seizures
- Usually lasts <24 hours

Moderate HIE-Sarnat Stage II

- Lethargy
- Reduced tone of the extremities and/or trunk
- Diminished pupil, gag and suck reflex
- Possible clinical seizures

<http://cpcare.org/hie/sarnat-grading-scale-of-hie>



Clinical Staging of HIE – Sarnat Grading Scale of HIE

(Sarnat and Sarnat, 1976)

Severe HIE-Sarnat Stage III

- Coma (cannot be roused)
- Weak or absent respiratory drive
- No response to stimuli
- Flaccid tone
- Diminished or absent pupil, gag and suck reflex
- Diminished tendon reflexes
- EEG severely abnormal (suppressed or flat with or without seizures)

<http://cpcare.org/hie/sarnat-grading-scale-of-hie/>



Palmetto Health Richland NICU Criteria for HIE

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CANDIDACY FOR THERAPEUTIC / NEUROPROTECTIVE HYPOTHERMIA CHECKLIST

Directions: Start at the top and work through each numbered component

Note: If patient is less than six hours old and meets the gestation, weight and blood gas criteria and has a witnessed seizure, patient is eligible for hypothermia regardless of additional exam findings. Consult the tertiary center where cooling is offered for discuss any questions or concerns.

TIME of birth: _____ a.m./p.m. CURRENT AGE in hours/minutes: _____ h. _____ min.

If current age > 6 hours, call tertiary center before proceeding. There are ongoing studies evaluating therapeutic hypothermia for infants 6 to 24 hours old and your tertiary facility may be participating.

Clinical Information	Criteria (place a check in the box that corresponds to the patient information)	Instructions
Gestation	1 ≥ 36 weeks gestation <input type="checkbox"/> < 36 weeks gestation <input type="checkbox"/>	Go to 2 Weight Not eligible
Weight	2 ≥1800 grams <input type="checkbox"/> < 1800 grams <input type="checkbox"/>	Go to 3 Blood gas Not eligible
Blood gas pH = ____ Base deficit (BD) = ____ Source: Cord _____ _____ <input type="checkbox"/> Or 1st baby blood gas at < 1 hour of life. Time obtained: ____ : ____ Arterial _____ Capillary _____ Venous _____ <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	3 pH ≤ 7.0 or Base deficit > 16 <input type="checkbox"/> No gas obtained <input type="checkbox"/> Or pH 7.01 to 7.15 <input type="checkbox"/> Or Base deficit 10 to 15.9 <input type="checkbox"/> pH > 7.15 or Base deficit < 10 <input type="checkbox"/>	Criteria met thus far. Go to EXAM * Go to 4 History of acute perinatal event May not be eligible; Go to 4 History of acute perinatal event
Acute perinatal event (check all that apply)	4 Variable / late fetal HR decelerations <input type="checkbox"/> Prolapsed / ruptured or tight nuchal cord <input type="checkbox"/> Uterine rupture <input type="checkbox"/> Maternal hemorrhage / placental abruption <input type="checkbox"/> Maternal trauma (e.g. vehicle accident) <input type="checkbox"/> Mother received CPR <input type="checkbox"/> No perinatal event <input type="checkbox"/> Or Indeterminate what the event was because of home birth or missing information <input type="checkbox"/>	Any checked, Go to 5 Apgar score May not be eligible; Go to 5 Apgar score
Apgar score at 1 minute _____ 5 minutes _____ 10 minutes _____	5 Apgar ≤ 5 at 10 minutes (yes) <input type="checkbox"/> Apgar ≤ 5 at 10 minutes (no) <input type="checkbox"/> (no, was 6 or greater at 10 minutes) <input type="checkbox"/>	Criteria met thus far. Go to EXAM * Go to 6 Resuscitation after delivery
Resuscitation after delivery (check all that apply) ____ PPV / intubated at 10 minutes ____ CPR ____ Epinephrine administered	6 Continued need for PPV or intubated at 10 minutes? (yes) <input type="checkbox"/> PPV / intubated at 10 minutes? (no) <input type="checkbox"/>	Criteria met thus far. Go to EXAM * May not be eligible; Go to EXAM *

Figure 2.6. Evaluating candidacy for therapeutic/neuroprotective hypothermia. Start at the top and work through each numbered component. When directed to proceed to the exam, refer to the exam found in Figure 2.7. If there is missing data, such as a known perinatal event and/or Apgar scores, and you are in doubt whether the patient qualifies for cooling, consult the tertiary center promptly to discuss the patient.

*Action line template courtesy of Neurology Neurology Program at Children's National Medical Center, Washington, D.C. Adapted with permission.



Scoring Chart – Neuro Exam from PHR

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Circle findings for each domain.			
Patient is eligible for hypothermia if 3 or more domains with findings in columns 2 or 3.			
Domain	1	2	3
Seizures	None	Common: focal or multifocal seizures <small>Note: If the infant is < 6 hours old and meets gestation, weight, and blood gas criteria, and has a witnessed seizure, patient is eligible for hypothermia regardless of the rest of these exam findings.</small>	Uncommon (excluding decerebration) Or Frequent seizures
Level of consciousness	Normal Hyperalert	Lethargic Decreased activity in an infant who is aroused and responsive • Can be irritable to external stimuli (i.e., touch)	Stuporous / Comatose Not able to arouse and unresponsive to external stimuli
Spontaneous activity when awake or aroused	Active Vigorous, doesn't stay in one position	Less than active, not vigorous	No activity whatsoever
Posture	Moving around and does not maintain one position	Distal flexion, complete extension, or "frog-legged" position	Decerebrate with or without stimulation (all extremities extended)
Tone	Normal – resists passive motion Hypertonic, jittery	Hypotonic or floppy, either focal or general	Completely flaccid like a rag doll
Primitive reflexes	Suck: Vigorously sucks finger or ET tube Moro – normal: Extension of limbs followed by flexion with stimulus	Suck: Weak Moro: Incomplete	Suck: Completely absent Moro: Completely absent
Autonomic system	Pupils: • Normal size (~1/2 iris diameter) • Reactive to light Heart rate: Normal, > 100 bpm Respirations: • Regular spontaneous breathing	Pupils: • Constricted (<3 mm estimated), but react to light Heart rate: • Bradycardia (< 100 bpm, variable up to 120 bpm) Respirations: • Periodic, irregular breathing effort	Pupils: • Skew gaze, fixed, dilated, not reactive to light Heart rate: • Variable, inconsistent rate, irregular heart rate, may be bradycardic Respirations: • Completely apneic, requiring positive pressure ventilation (PPV) and/or ET intubation and ventilation

Figure 2.7. Neurological exam to evaluate candidacy for therapeutic/ neuroprotective hypothermia. If in doubt whether the patient qualifies for cooling, consult the tertiary center promptly to discuss the patient.

Neurologic Exam template courtesy of Neonatology/Neurology Program at Children's National Medical Center, Washington, D.C. Adapted with permission.

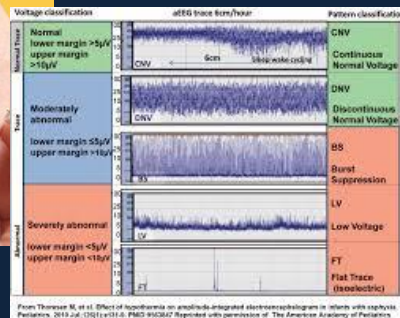


Systemic Complications of HIE

- Acute renal failure
- Myocardial dysfunction and hypotension
- Elevated LFT's
- Coagulation impairment
- **SUPPORTIVE CARE REQUIRED!**

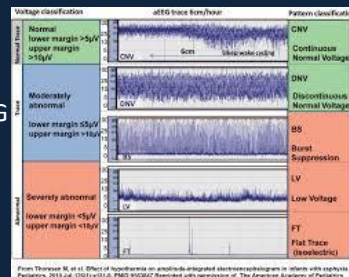


Assessment Tools



Assessment Tools in HIE

- Electroencephalogram (EEG)
 - Neonatal seizures
 - Presence and severity of encephalopathy
- Amplitude integrated EEG (aEEG)
 - Useful to distinguish mild from severe neonatal encephalopathy
 - Marginal abnormal or normal aEEG reassuring for good outcome
 - Severely abnormal aEEG raises probability of death or severe disability from 25% to 75%

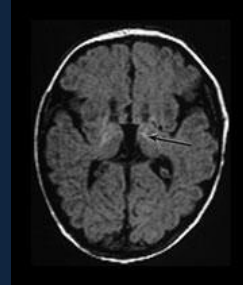


<http://www.uptodate.com/contents/clinical-features-diagnosis-and-treatment-of-neonatal-encephalopathy#H7>



Assessment Tools in HIE

- Neuroimaging
 - Cranial ultrasound
 - Not a sensitive tool to identify milder white matter abnormalities
 - CT Scan
 - Milder degrees of edema and white matter injury can be difficult to detect
 - MRI Scan
 - Most appropriate scan
 - Most sensitive for detecting cortical and white matter injury, deep gray matter lesions, arterial infarction and developmental brain malformations



<http://www.uptodate.com/contents/clinical-features-diagnosis-and-treatment-of-neonatal-encephalopathy#H3>



Laboratory Test

- Serum Electrolytes
 - Daily assessments
 - Syndrome of inappropriate antidiuretic hormone secretion (SIADH)
 - Low sodium, potassium and chloride levels
 - Decreased urine out put
 - Weight gain
 - Renal function Test
 - Creatinine levels
 - BUN
 - Cardiac and liver enzymes
 - Assess degree of hypoxic ischemic injury
 - Coagulation Studies
 - PT, PTT and Fibrinogen
 - ABG
 - Acid base status





Therapeutic Neuroprotective Hypothermia



Mechanism of Action of Hypothermia Therapy

- Hypothermia helps prevent disruptions to cerebral metabolism
- Hypothermia decreases the cerebral metabolic rate for glucose and oxygen
- Hypothermia decreases the loss of high energy phosphates

https://en.wikipedia.org/wiki/Hypothermia_therapy_for_neonatal_encephalopathy



Mechanism of Action of Hypothermia Therapy

- Effects at a cellular level
 - Reduces vasogenic edema
 - Haemorrhage and neutrophil infiltration after trauma
 - Limits intracellular calcium accumulation
 - Free radical production is lessened
 - Reduces activation of the coagulation cascade
- Secondary Cerebral Energy Failure
 - Hypothermia reduces delayed cerebral lactic alkalosis
 - Hypothermia prevents increase in cytotoxic edema and loss of cerebral cortical activity

https://en.wikipedia.org/wiki/Hypothermia_therapy_for_neonatal_encephalopathy



Cooling Process

- Whole body cooling using blanket and servo controlled cooling system
 - The aim is to cool infants with moderate to severe HIE within 6 hours of life
 - Goal esophageal temp: 33.5°C (92.3°F)
 - Continued for 72 hours
 - Supportive care as indicated
 - NPO
 - Respiratory Support
 - Circulatory Support
 - Anticonvulsants
 - Antibiotics



<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3743149/>



Cooling Process

- Nursing interventions
 - Recommended staffing: 1 - 1 nursing care
 - Insert esophageal temp probe 2cm above diaphragm
 - Place infant on pre-cooled blanket and attach esophageal temp probe to blanket
 - Turn all external heat source off
 - Vital signs q hour for 12 hours then q 2hours
 - Blood gases
 - Lab work



Expected Effects of Cooling

- The infants will feel cool
 - Cool to touch and shivering
 - Skin temp 2 degrees lower than core temp
- Lower Heart Rates
 - 90-110/min
- Lower cardiac outputs
 - Adequate for metabolic needs



Rewarming

- Initiated after 72 hours of cooling
- Slow rewarming
 - 0.5°C per hour until desired temp of 36.5°C (97.7°F)
 - Approximately over 4-6 hours
 - Cooling device discontinued
 - Temperature control using servo mode on radiant warmer



Role of Referring Hospital In Optimizing The Outcome

- Early identification of possible candidates
 - History of adverse perinatal event
 - Laboratory evidence of acidosis
 - Signs of encephalopathy on examination



Optimizing Care

- Early consultation with the Regional Perinatal Center (RPC)
- Stabilization
 - Avoid hypoglycemia and hyperthermia
 - Identification and treatment of seizures
 - Arrange for transport
 - Passive cooling
 - Initiated by turning off radiant warmer/isolette
 - Time to reach target temperature: ~2 hours



Cooling Before and During Transport Advantages

- Most cooled babies are outborn
- Ensures initiation of cooling within the therapeutic window
- Avoids hyperthermia



Cooling Before and During Transport Disadvantages

- No data on beneficial effects
- Risk of cooling ineligible candidates
- Risk of over or under cooling
- Vermont Oxford Encephalopathic Registry
 - Third of infants are born at other facilities and not admitted to referring center until after 6 hours of age
 - Study



Prognoses Mortality/Morbidity

- Reduction of death or major neurodevelopmental disability to 18 months of age:
 - 25% overall
 - 32% for moderate encephalopathy
 - 18% for severe encephalopathy
- **Death or severe disability at 18 months of age significantly reduced!!**



Cooling Studies In Progress

- Therapeutic hypothermia beyond 6 hours
 - Infants 6-24 hours of age
- Late preterm infants: 34-36 weeks gestation
- Lower cooling temperatures: 32°C
- Longer cooling time: 120 hours

<http://pediatrics.aappublications.org/content/133/6/1146.full>



Pharmacologic Management As An Adjunct To Hypothermia

- Neuroprotective Agents
- Inhaled Xenon Gas
 - Phase I and II study
- Erythropoietin
 - Phase II study
 - Doses of 1000 U/kg IV
- Darbepoetin
 - Phase I and II study in progress
- Clonidine
 - Phase I and II study
 - Improve sedation, shivering and agitation

<http://pediatrics.aappublications.org/content/133/6/1146.full>



Case Study

Infant was a 3693 grams, 40 4/7wk white female infant born to a G3P1012. Delivery was complicated by maternal cardio-respiratory arrest. Infant delivered by vacuumed as mother received chest compressions. Mother required epinephrine after infant delivered. Infant required PPV and intubation in delivery room. APGARS 1/5/5 Cord gas (arterial) Ph: 6.92 HCO₃: 22, base deficit: 13.7. Infant transferred to NICU on IMV. Upon arrival to NICU, infant with some spontaneous movement and breathing. Infant placed on ventilator and cooling blanket. First ABG in NICU was 7.30/27/97/13.3/-12.2. Admission exam: infant with decreased activity and hypotonic tone but responds to exam. Hand held fistled. Weak suck, Moro present but decreased. No seizure activity noted.



Case Study

Infant extubated shortly after admission to the NICU. UAC was placed. Admission HUS was normal. Cooling per protocol. Core temperature maintained at 33.5°C for 72 hours and then rewarmed at 0.5°C/hr over 6 hours. No complications noted during the cooling process. Repeat HUS completed on 6/4/15 and was normal. Feedings were started on 6/5/15 and infant advanced to full feedings with all nipple feedings on 6/8/15. MRI completed on 6/5/15 and showed no evidence of ischemic injury.

Infant was discharged home with parents on 6/10/15. Home health PT and baby net referrals made. Infant to be seen in the NICU f/u clinic in 6 months.



Conclusion

- HIE is a major cause of infant morbidity and mortality
- Therapeutic hypothermia is the only known therapy for reducing morbidity and mortality
- The AAP established criteria for hypothermic cooling from clinical trials



Questions?

- Post your questions in the box...
- Lines now open
 - Please make sure your phone is not muted so we can hear your questions!



Thank you!

- **You will receive an email following the webinar with an evaluation, please complete the evaluation and your CE certificate will be sent electronically.**
- Please contact me for any further questions.
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