UWHealth

Hypoxic Ischemic Encephalopathy (HIE) - Neonatal - Inpatient Clinical Practice Guideline

Note: Active Table of Contents – Click each header below to jump to the section of interest

Table of Contents

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Introduction

Hypoxic-ischemic encephalopathy (HIE) occurs in 1-3 per 1000 term births and accounts for 22% of neonatal deaths worldwide.[1-3] Infants with HIE suffer a high rate of morbidity and mortality. Therapeutic hypothermia is a neuroprotective strategy which has become a standard of care for neonatal HIE and can improve outcomes in death and disability. Given the timing constraints needed to initiate therapeutic hypothermia, it is important that clinicians be aware of recommended protocols and practices. This guideline serves as a compendium on the medical management and care of infants with hypoxic-ischemic encephalopathy.

Scope

Intended User(s): Physicians, Advanced Practice Providers, Registered Nurses, Pharmacists

Objective(s): To provide guidance on the medical management of neonates with suspected hypoxic ischemic encephalopathy

Target Population: Neonatal infants with suspected or confirmed diagnosis of HIE in the inpatient setting/Neonatal Intensive Care Unit (NICU)

Clinical Questions Considered:

- Which infants (i.e., inclusion criteria) should undergo therapeutic hypothermia?
- When should amplitude electroencephalography (aEEG) be initiated?
- What labs should be obtained to monitor neonates with HIE?
- What imaging studies should be obtained upon admission and subsequently to assess neurologic injury?
- What supportive care measures are recommended for infants with HIE?

Recommendations

Therapeutic hypothermia

Since 2005, therapeutic hypothermia has become a standard neuroprotective strategy used in the management of infants with hypoxic ischemic encephalopathy as a result of the improved clinical outcomes demonstrated in randomized controlled trials.[4, 5]

Inclusion and Exclusion criteria

Infants with HIE must meet the following 3 criteria to be considered for therapeutic hypothermia: [5-11] *(UW Health Moderate quality evidence, strong recommendation)*

1. Gestational age ≥ 35 and 0/7 weeks[12] *(UW Health Low quality of evidence, conditional recommendation*
2. Birth weight ≥ 1800 grams
3. ≤ 6 hours of life

Therapeutic hypothermia for neonatal HIE is NOT recommended for patients who meet the following **exclusion criteria:**

- Presence of major congenital anomalies
- Moribund infants for whom no additional intensive therapy will be offered, as determined by attending neonatologist

The following are considered relative contraindications, in which case the potential risks and benefits will be evaluated by the neonatologist to determine eligibility:[6-10] *(UW Health Moderate quality evidence, conditional recommendation)*

- Infant > 6 hours of life at time of initial referral/evaluation[4, 13]
- Severe hemodynamic compromise
    - Consult the pediatric intensivist when considering therapeutic hypothermia for an infant with critical congenital heart disease
- Severe coagulopathy with active bleeding
- Confirmed venous sinus thrombosis

Eligible infants will be evaluated in two steps:

Step I: Clinical and biochemical criteria

- History of acute perinatal event (e.g., uterine rupture, placental abruption, umbilical cord prolapse or avulsion, or severe fetal heart rate abnormality)
- APGAR score < 6 at 10 minutes of life
- Prolonged resuscitation, defined as positive pressure ventilation (via bag-mask or advanced airway) initiated at birth and continued for at least 10 minutes
- pH ≤ 7.0 on arterial cord blood gas or first postnatal hour blood gas
- Base deficit ≥ 12 mEq/L on arterial cord blood gas or first postnatal hour blood gas

Infants meet clinical and biochemical inclusion criteria if A <u>or</u> B are met:

A. pH ≤ 7.0 **<u>or</u>** base deficit ≥ 12 mEq/L
B. pH between 7.0 and 7.15 with history of an acute perinatal event **<u>and</u>** at least one of the following:
    i. Apgar score < 6 at 10 minutes
    ii. Prolonged resuscitation

Step II: Neurologic evaluation using neonatal encephalopathy exam

- <u>Inborn</u> evaluation should occur after 15 minutes of life using .<u>HIEEXAM</u>
- <u>Outborn</u> evaluation should be done with referring site under guidance of medical control, use of telemedicine (if able) is strongly encouraged

Infant meets neonatal encephalopathy criteria if A <u>or</u> B are met:

A. Seizures
B. Moderate or severe encephalopathy using neonatal encephalopathy exam

(See Appendix1: Neonatal Encephalopathy Exam or EPIC smartphrase .HIEEXAM)

Outside referral for therapeutic hypothermia

Eligibility for therapeutic hypothermia for patients born outside of the UW Health system will be determined in conjunction with the referring provider and admitting neonatologist.

Therapeutic strategy

It is recommended that therapeutic hypothermia (i.e., active or passive cooling) be initiated within 6 hours of life with a targeted esophageal temperature of 33.5-34.5°C and once targeted temperature is reached it should be maintained for 72 hours.[5-10] *(UW Health Moderate quality evidence, strong recommendation)*

For further information on conducting cooling on transport, passive cooling and cooling in the Neonatal Intensive Care Unit, refer to UW Health Neonatal Whole Body Cooling Procedure.

Re-warming strategy

It is recommended to begin re-warming 72 hours after the first esophageal temperature between 33.5-34.5°C was reached.[6-9] *(UW Health Moderate quality evidence, strong recommendation)*

Slow rewarming of the patient is preferred and is recommended at the rate of 0.5°C per hour to a core body temperature of 36.5°C (approximately 6 hours).[6, 8, 9, 14, 15] *(UW Health Moderate quality evidence, strong recommendation)*

For additional information on how to re-warm patients, refer to UW Health Neonatal Whole Body Cooling Procedure

Management of HIE

Monitoring

Imaging studies

A babygram is recommended upon admission. *(UW Health Very low quality of evidence, strong recommendation)* It is also important to confirm esophageal probe placement.

HIE patients should also have a cranial ultrasound with Doppler conducted upon admission.[16, 17] *(UW Health Low quality of evidence, strong recommendation)*

In infants undergoing therapeutic hypothermia, a non-sedated (feed & swaddle) brain MRI and MRS is recommended on Day of Life 4-5.[10, 17-21] *(UW Health Moderate quality of evidence, strong recommendation).* If the patient is unable to undergo brain MRI within the recommended time frame, postponing the brain MRI until Day of Life 10 – 14 should be considered. While a non-sedated brain MRI/MRS may be performed at any other timepoint as clinically indicated, imaging between Day of Life 7 – 10 may have a greater risk of a failing to show brain injury (false negative scan). Consider obtaining a follow-up MRI and MRS in patient on Day of Life 10-14, particularly in those cases with discrepant clinical-imaging findings or those infants with an earlier abnormal MRI/MRS examination.[18-21] *(UW Health Low quality of evidence, conditional recommendation)*

Note: When ordering cranial ultrasound or brain MRI it is important to note "HIE Protocol" in the comment section of order to ensure the appropriate imaging study is performed.

If the patient appears severely encephalopathic and the family is considering withdrawing support, consider obtaining brain MRI at 24-28 hours of life (or when clinically appropriate).[17] *(UW Health Very low quality of evidence, conditional recommendation)*

Near-infrared spectroscopy (NIRS)

Cerebral and renal NIRS monitoring is recommended for all HIE patients.[15, 22] *(UW Health Low quality of evidence, strong recommendation)*

Labs

Table 1 outlines suggested labs to obtain when monitoring HIE infants during therapeutic hypothermia.[15, 18, 23] *(UW Health Low quality evidence, strong recommendation)*

Table 1. Therapeutic Hypothermia- Labs for monitoring

Lab (Normal Range)	Suggested frequency
Temperature corrected blood gas, lactate, ionized calcium (iCa)[13] (4.5-5.3 mg/dL which equals: 1.12-1.32 mmol/L; 2.25-2.65 mEq/L)	Every 6 hours for first 24 hours then every 12-24 hours (minimum during cooling) **Note:** Temperature corrected blood gases are available on the NICU ABL 90 and the main lab. To get temperature corrected readings, do the following: • On workstation order, clearly write patient's temperature at time of draw • If processed in the NICU, notify respiratory therapy of the patient's current temperature and desire for temperature corrected blood gases The temperature corrected values that will appear in Health Link include: • PH, TEMP CORRECTED • PCO2, TEMP CORRECTED • PO2, TEMP CORRECTED
Glucose[24]	Every hour during initiation of cooling until temp 33.5-34.5°C is reached; thereafter, check every 6 hours during cooling. During rewarming, check glucose at the start of rewarming, every 2 hours x 2, then PRN and with lab draws
Chemistries (Ca 8.7-10.1 mg/dL) (Mg 1.8-2.3 mg/dL) (K 4.0-6.0 mEq/L)	Check Electrolytes, Ca, Mg, Phos every 12-24 hours during cooling Consider monitoring during rewarming
CBC	Check every 12-24 hours
Cultures	Obtain blood culture; consider sputum and cerebral spinal fluid culture
PT/PTT/INR	Check every 24 hours
BUN/CR	Check every 12-24 hours
AST/ALT	Check every 24 hours

Neurologic

Sedation

It is important that infants undergoing therapeutic hypothermia be adequately sedated to avoid cold stress and because lack of sedation may impact the neuroprotective effect. Sedation level should target a Neonatal Pain, Agitation and Sedation Scale (NPASS) score of -1. Shivering should be avoided.[25] Use of benzodiazepines should be avoided. Morphine is preferred and may be given with the following dosing[7, 26, 27]:

- **Day 1**: Loading dose morphine 0.05 mg/kg intravenously [28, 29]
  - Start maintenance continuous infusion at 0.01 mg/kg/hr
  - Escalate infusion rate by 0.005 mg/kg/hr as needed
  - Provide bolus doses of morphine 0.02 mg/kg IV every 3-4 hours PRN
  - If continuous infusion not available, schedule morphine 0.05 mg/kg IV every 4 hours
- **Day 2:** – Wean continuous morphine infusion by half to avoid toxic accumulation; goal rate of 0.005 mg/kg/hr.
  - If patient is on scheduled morphine boluses instead of continuous infusion, decrease scheduled morphine by 50% as tolerated

- **2nd Line**: Consider starting dexmedetomidine 0.2 mcg/kg/hr if morphine infusion > 0.015 mg/kg/hr
    - Dexmedetomidine loading or bolus doses should NOT be administered due to the risk of bradycardia and hypotension
    - When administering dexmedetomidine, wean morphine infusion to lowest rate tolerated (may discontinue)

Pediatric Neurology consultation
It is recommended to obtain a Pediatric Neurology consultation for any HIE patient and that the complete neurology exam and neonatal encephalopathy exam (using .HIEEXAM Epic SmartPhrase) be documented. *(UW Health Very low-quality evidence, strong recommendation)*

Electroencephalography (EEG)
Amplitude-integrated EEG/continuous EEG monitoring is recommended upon admission to the NICU and through the re-warming process, or until patient has been seizure free for 24-72 hours (per Pediatric Neurology recommendation.)[30-32] *(UW Health Low quality of evidence, strong recommendation)*

Seizure management
Hypoxic-ischemic cerebral injury is the most common cause of early-onset neonatal seizures however there is not consensus regarding seizure prophylaxis or what is the best medication to treat seizures in these patients.[4, 18, 33, 34] If patient demonstrates clinical or electrographical seizures, consider load with one time dose of levetiracetam 50 mg/kg and refer to Neonatal Seizures – Neonatal – Inpatient/Emergency Department Clinical Practice Guideline for ongoing seizure management.[35] *(UW Health Low quality of evidence, conditional recommendation)*
Levetiracetam is preferred over phenobarbital because of its favorable side effect profile.[18, 35] *(UW Health Very low quality evidence, conditional recommendation)*

Fluids, Electrolytes and Nutrition

Patients should be "NPO" status until rewarmed.[6, 8, 23, 26] Emerging literature may support trophic enteral feeds of colostrum or breast milk during therapeutic hypothermia for some infants with HIE; however, the safety of this practice is not entirely clear.[36, 37] Until additional evidence becomes available, we will continue to practice NPO status during therapeutic hypothermia. *(UW Health Low quality of evidence, strong recommendation)*

Central access should also be established early on (e.g., UAC and double lumen UVC.) *(UW Health Very low quality of evidence, strong recommendation)* To avoid fluid overload and prevent cerebral edema, it is recommended to carefully manage fluid therapy. The recommended initial total fluid goal (TFG) is 50-60 mL/kg/day using D10W.[9, 18, 38] *(UW Health Low quality evidence, strong recommendation)*

If the patient becomes hypovolemic, treat with volume (e.g., normal saline, packed red blood cells.) *(UW Health Low quality evidence, conditional recommendation)*

If worsening acidosis to a base deficit > 10 mEq/L, consider normal saline 10mL/kg IV or sodium bicarbonate 1-2 mEq/kg IV over 30 minutes.[39] *(UW Health Low quality evidence, conditional recommendation)* Sodium acetate may also be added to maintenance fluids.

Cardiovascular

Blood pressure, cardiac output and systemic vascular resistance should be monitored to ensure that blood pressure remains in a safe range to avoid hypotension, and because hypoxic-ischemia can impair cerebral autoregulation.[18, 25] An echocardiogram is recommended if the patient is hemodynamically unstable or if there is concern for pulmonary hypertension. *(UW Health Low quality evidence, strong recommendation)*

It is recommended to continuously monitor blood pressure with an arterial line and also monitor cardiac activity via 3-lead electrocardiograph (EKG).[40] *(UW Health Low quality evidence, strong recommendation)* Blood pressure should be maintained in normal range (e.g., systolic 60-70 mm Hg, diastolic 40-50 mm Hg and mean arterial pressure 40-50 mm Hg.). If blood pressure support is needed, dopamine may be initiated at 2-5 mcg/kg/minute.[18, 41, 42]*(UW Health Low quality evidence, conditional recommendation)* Dobutamine may be given as alternative to dopamine. If needed, initiate dobutamine 2-5 mcg/kg/minute (normal range 5-20 mcg/kg/minute)[18, 41]

For cooled infants, bradycardia is to be expected (heart rate 80-100 bpm)[25, 43]
If blood pressure is stable, deep bradycardia (heart rate < 80 bpm) may be tolerated. If not tolerated, raising core temperature to 34°C may be sufficient. *(UW Health Low quality evidence, conditional recommendation)* If symptomatic bradycardia exists, consider administering dopamine. *(UW Health Very low-quality evidence, conditional recommendation)*

Respiratory

Hypocapnia is harmful to HIE patients because it decreases cerebral perfusion and oxygen release from hemoglobin. It is also associated with death and poor neurodevelopmental outcomes.[18, 44, 45] Hypocapnia should be avoided in HIE patients and the goal PCO_2 is 45-50 mmHg.[25, 45] *(UW Health Low quality evidence, strong recommendation)*

Hyperoxia increases oxidative stress and free radical production, leading to detrimental effects on patients. It has also been associated with death and poor long-term outcomes in HIE patients.[18, 44] Therefore, it is recommended that hyperoxia be avoided in HIE patients and the goal PaO_2 is 80-100 mmHg with SpO_2 94-98%. *(UW Health Low quality evidence, strong recommendation)*

Infectious Disease

It is recommended that sepsis be ruled out in all patients with HIE.[46] *(UW Health Low quality evidence, strong recommendation)* A lumbar puncture may also be considered to rule out meningitis infection.[47] (*UW Health Low quality of evidence, conditional recommendation)*

During sepsis workup, empiric treatment with ampicillin and gentamicin is recommended for all infants being treated with therapeutic hypothermia, with the following dosing[48, 49]: *(UW Health Low quality evidence, conditional recommendation)*

- Ampicillin 100 mg/kg/dose intravenously every 12 hours
    - If concern for meningitis, increase dose to ampicillin 100 mg/kg IV Q8 hours
- Gentamicin 4 mg/kg/dose every 24 hours, with each dose administered intravenously over 30 minutes.
- In the event of renal failure or elevated creatinine, ceftazidime at 50mg/kg/dose intravenously every 12 hours is recommended in lieu of gentamicin.[50] *(UW Health Low quality evidence, conditional recommendation)*

Skin

To prevent pressure ulcers, it is recommended to maintain pressure relieving device in HIE patients and to reposition every 2 hours.[51-53] *(UW Health Moderate quality evidence, strong recommendation)*

Patients should also be monitored and assessed for development of pressures ulcers and fat necrosis.[51-54] *(UW Health Moderate quality evidence, strong recommendation)*

Development

All patients will have a physical therapy, occupational therapy and speech consults ordered on admission to the NICU. Evaluation with the Prechtl General Movement Assessment (GMA) and Test of Infant Motor Performance (TIMP) is strongly recommended prior to discharge.[55-57]

Outpatient Follow-up

All patients should be followed up at 3 months of age after discharge from the hospital with Waisman Center newborn follow-up clinic or a neurodevelopment clinic accessible to patient. *(UW Health Very low-quality evidence, strong recommendation)* Consultation with Waisman clinic may occur prior to discharge to assist with transition of care.

Patients should be followed-up with Pediatric Neurology per the recommendation of the Pediatric Neurology service. *(UW Health Very low-quality evidence, conditional recommendation)*

Disclaimer

Clinical practice guidelines assist clinicians by providing a framework for the evaluation and treatment of patients. This guideline outlines the preferred approach for most patients. It is not intended to replace a clinician's judgment or to establish a protocol for all patients. It is understood that some patients will not fit the clinical condition contemplated by a guideline and that a guideline will rarely establish the only appropriate approach to a problem.

Methodology

Development Process

Each guideline is reviewed and updated approximately every 3 years, in consideration of the primary literature and relevant practice changes. All guidelines are developed using the guiding principles, standard processes, and styling outlined in the UW Health Clinical Practice Guideline Resource Guide. This includes expectations for workgroup composition and recruitment strategies, disclosure and management of conflict of interest for participating workgroup members, literature review techniques, evidence grading resources, required approval bodies, and suggestions for communication and implementation.

Methods Used to Collect the Evidence:

The following criteria were used by the guideline author(s) and workgroup members to conduct electronic database searches in the collection of evidence for review.

Literature Sources:

- Electronic database search (e.g., PubMed)
- Databases of systematic reviews (e.g., Cochrane Library)
- Perlman JM. *Neurology: neonatology questions and controversies*. Philadelphia: Elsevier/Saunders; 2012.
- MacDonald MG, Ramasethu J, Rais-Bahrami K. *Atlas of procedures in neonatology*. Philadelphia: Wolters Kluwer/Lippincott Williams & Wilkins Health; 2013

Time Period: November 2017 to April 2022

The following is a list of various search terms that were used individually or in combination with each other for literature searches on PubMed: neonatal, hypoxic ischemic encephalopathy, HIE, ischemic hypoxia, therapeutic hypothermia, neonates, sedation.

Methods to Select the Evidence:

Literary sources were selected with the following criteria in thought: English language, publication in a MEDLINE core clinical journal and strength of expert opinion.

Methods Used to Formulate the Recommendations:

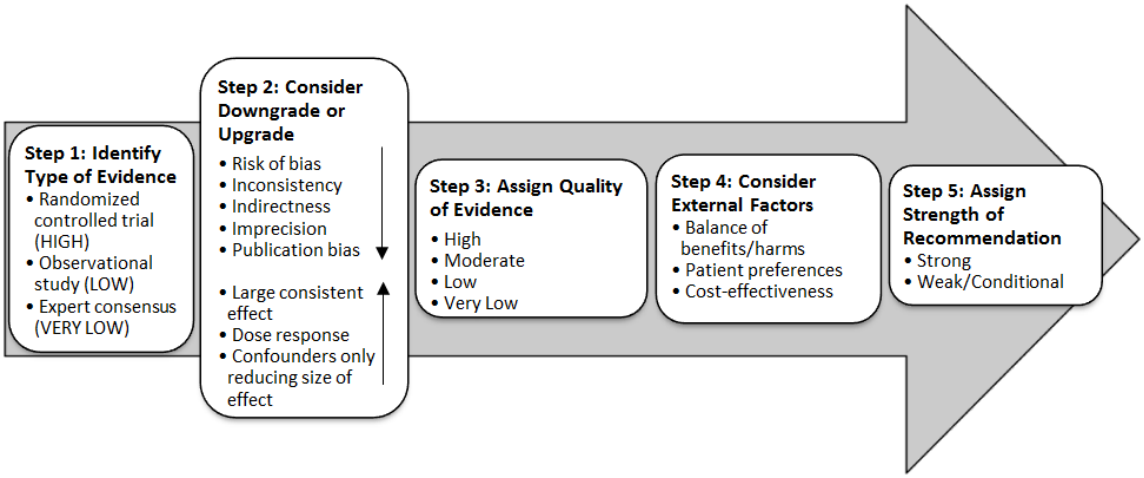
The workgroup members agreed to adopt recommendations developed by external organizations and/or created recommendations internally via a consensus process using discussion of the literature and expert experience/opinion. If issues or controversies arose where consensus could not be reached, the topic was escalated appropriately per the guiding principles outlined in the UW Health Clinical Practice Guideline Resource Guide.

Methods Used to Assess the Quality of the Evidence/Strength of the Recommendations:

Recommendations developed by external organizations maintained the evidence grade assigned within the original source document and were adopted for use at UW Health.

Internally developed recommendations, or those adopted from external sources without an assigned evidence grade, were evaluated by the guideline workgroup using an algorithm adapted from the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology (see **Figure 1**).

Figure 1. GRADE Methodology adapted by UW Health



Rating Scheme for the Strength of the Evidence/Recommendations:

GRADE Ranking of Evidence

High	We are confident that the effect in the study reflects the actual effect.
Moderate	We are quite confident that the effect in the study is close to the true effect, but it is also possible it is substantially different.
Low	The true effect may differ significantly from the estimate.
Very Low	The true effect is likely to be substantially different from the estimated effect.

GRADE Ratings for Recommendations For or Against Practice

Strong	The net benefit of the treatment is clear, patient values and circumstances are unlikely to affect the decision.
Conditional	Recommendation may be conditional upon patient values and preferences, the resources available, or the setting in which the intervention will be implemented.

Recognition of Potential Health Care Disparities: None identified.

Collateral Tools & Resources

The following collateral tools and resources support staff execution and performance of the evidence-based guideline recommendations in everyday clinical practice.

Metrics

- Number of infants who received therapeutic hypothermia within first 6 hours of life
- Number of HIE suspected=infants who received therapeutic hypothermia that were NOT cooled for 72 hours
- Number of infants < 36 weeks with suspected HIE who received therapeutic hypothermia

Order Sets & Smart Sets

Whole Body Cooling/Therapeutic Hypothermia-NICU-Admission [4746]
IP – aEEG/CEEC/Video EEG – Neonatal – Supplemental [5305]
IP – Seizure – Neonatal – Supplemental (5057]

Patient Resources

HFFY #7650 - Hypothermia Treatment (Whole Body Cooling) for Hypoxic Ischemic Encephalopathy

Procedures

UW Health Neonatal Whole Body Cooling Procedure

Appendix A. Neonatal Encephalopathy Exam* (.HIEEXAM)[34, 58-60]

	Level of Encephalopathy			
	Normal/None	**Mild**	**Moderate**	**Severe**
1. Level of Consciousness	0 – Normal/Alert	1 – Hyperalert or irritable (responsive to minimal stimuli)	2 – Lethargic	3 – Stupor or coma
2. Spontaneous Activity	0 – Normal	-----	2 – Decreased activity	3 – No activity
3. Posture	0 – Predominantly flexed	1 – Mild flexion of distal joints (fingers, wrist)	2 – Flexion of distal joints or complete extension	3 – Decerebrate
4. Tone	0 – Strong flexor tone in all extremities	1 – Slightly increased tone in extremities	2a – Hypotonia (focal or general) 2b – Hypertonia (focal or general)	3a – Flaccid 3b – Rigid
5. Primitive Reflexes†:				
Suck	0 – Strong, coordinated, easy to elicit	1 – Weak, coordinated	2 – Weak and uncoordinated, and/or bite	3 – Absent
Moro	0 – Complete	1 – Exaggerated	2 – Incomplete	3 – Absent
6. Autonomic System†:				
Pupils	0 – Normal	1 – Mydriasis (dilated), reactive	2 – Myosis (constricted), reactive	3 – Deviated/unequal, dilated, or fixed/ nonreactive to light
Heart Rate	0 – Normal: 100 – 160 bpm	1 – Tachycardia: >160 bpm	2 – Bradycardia: <100 bpm	3 – Variable
Respiration	0 – Normal: regular respirations	1 – Tachypnea, Hyperventilation	2 – Periodic breathing	3a – Apnea, requires on-going PPV or intubation, and has spontaneous breaths 3b – Apnea, requires on-going PPV or intubation, and does not have spontaneous breaths

*This encephalopathy exam is based primarily on the version found in Chalak et al.[59]. Slight modifications have been made based on consideration of numerous published variations of encephalopathy exam scoring systems[60].

† For Primitive Reflexes (Suck, Moro) and Autonomic System (Pupils, Heart Rate, Respirations), the item with the highest score determines the level of encephalopathy.

- **No encephalopathy**: score of 0 in all six categories.
- **Mild encephalopathy**: < three categories with a score of 2 or 3, but has a score of 1, 2, or 3 in at least one category.
- **Moderate encephalopathy**: score of 2 in three or more categories.
- **Severe encephalopathy:** score of 3 in three or more categories.

Neonatal Encephalopathy Exam Definitions[61]

1. Level of Consciousness

Hyperalert - Full wakefulness with eyes open/staring but decreased frequency of blinking/tracking. Spontaneous motor activity normal or decreased with lowered threshold to all stimulus types.

Irritability - Lowered threshold with excessive response to all stimulus types. Can be seen with varied states including hyperalert, lethargy, and obtundation.

Lethargy - Slightly delayed but complete response to stimuli with slightly increased threshold for eliciting responses and decreased spontaneous movement

Obtundation - Delayed and incomplete responses with markedly increased threshold to all sensory stimuli and little or no motor activity

Stupor - No spontaneous eye opening and tactile stimulation elicits poorly sustained eye opening. Responds only to strong, noxious stimuli. Absent gag, corneal reflex.

Coma - No eye opening with vigorous tactile stimulation.

2. Spontaneous Activity

Decreased spontaneous activity - Decreased frequency or amplitude of spontaneous facial and extremity movements.

Absent spontaneous activity - Movements absent.

3. Tone

Hypotonia - Focal or generalized decreased resistance to passive movement. Associated with greater extension of the extremities than normal. *Must remove positioning barriers for accurate tone examination.

Hypertonia - Focal or generalized increased resistance to passive movement. Associated with greater flexion of the extremities than normal. *Must remove positioning barriers for accurate tone examination.

Flaccid - "Flat on the mat" appearance. May be associated with frog-leg posturing with arms and hips/legs lying in abduction. *Must remove positioning barriers for accurate tone examination.

Rigidity - "Lead pipe" feel of extremities, severe hypertonia with extreme resistance to passive movement. Does not depend on imposed speed or threshold of movement. Unilateral contraction of antagonist or agonist muscle groups can occur with rigidity, but the limb does not tend to return to a fixed posture or extreme joint angle. May be associated with exaggerated deep tendon and tactile reflexes.

4. Posture

Distal flexion - Fingers, toes in strong flexion; incomplete extension of fingers when stroked on dorsal surfaces. Thumbs flexed, adducted, opposed across palms (i.e. "cortical thumbs").

Decerebrate posturing - Head, neck, and back are arched in extension (opisthotonos), elbows are extended, wrists are pronated, and hips are adducted.

5. Primitive Reflexes: Suck

Weak suck - Some sucking noted, but it is not as vigorous or sustained as it should be. A pacifier or gloved finger can be easily pulled from the mouth.

Absent suck - No sucking or root reflex elicited.

Bite - Insertion of pacifier or gloved finger into mouth elicits neonate to "clamp down" or bite object. No sucking motion elicited.

5. Primitive Reflexes: Moro

Incomplete Moro – The Moro reflex is elicited by holding the baby's head and shoulders off the mat with arms held in flexion on chest. While supporting the head and neck, the examiner suddenly lets the head and shoulder drop while releasing the arms. The arms should fully abduct and extend, then return towards midline with the hand open and the thumb and index finger forming a "C" shape. An incomplete Moro is marked by absence of any component or any asymmetry in movements. Incomplete Moro reflex often extends irregularly but typically does not return to midline.

Absent Moro – Absence of any reflexive activity (see above for method of eliciting Moro reflex).

6. Autonomic System: Pupils

Dilated pupils (mydriasis) - Normal pupil size for term newborns is 3.9 mm +/- 0.8 mm. Dilated pupils are larger than this even in bright light.

Constricted pupils (miosis) - Normal pupil size for term newborns is 3.9 mm +/- 0.8 mm. Constricted or pinpoint pupils are smaller than this even in dim light.

Unequal; Fixed; Dilated; Poor light reflex pupils - Pupils that are not normally symmetrically aligned or symmetrically dilated, are fixed in position, or that do not accommodate (constrict) in the presence of light.

6. Autonomic System: Heart Rate

Tachycardia – Resting heart rate > 160 beats per minute, typically 170-190 beats per minute.

Bradycardia - Resting heart rate of < 100 beats per minute, typically 80-90 beats per minute. Only occasional increases to 120+ beats per minute are noted.

Variable heart rate - Resting heart rate varies considerably without a consistent baseline.

6. Autonomic System: Respiration

Periodic breathing - Three or more respiratory pauses of three seconds or longer separated by normal breathing for less than 20 seconds. Often associated with shallow breathing pattern.

Apnea - Absence of airflow and respiratory effort lasting 20 seconds or longer. Apnea may also be present if a respiratory pause is shorter than 20 seconds but is associated with heart rate change or oxygen desaturation.

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