Neonatal Hematology

Thrombocytopenia cont.
(Plt < 150)

Management cont.

Platelet goals:

GA	Symptomatic	Asymptomatic
Term	>50K-100K	>20K-30K
Pre-term	>100K	>50K

Neonatal Alloimmune Thrombocytopenia:
- Goal Plts> 20K to 30K if no active bleeding (transfuse antigen negative platelets)
- Check HUS
- Consider Steroids and IVIG
- Maternal Platelet typing

Neonatal Neurology

Intraventricular Hemorrhage Screening (IVH)

Indications for Head Ultrasound (HUS)
- GA<32 wks
- BW<1500 grams
- Anything suspicious for IVH (low HCT, low Plts, unstable BP, cardiopulmonary arrest, pneumothorax, prolonged hypotension, asphyxia)
- Pre/during ECMO.
- Timing on DOL 3, 7-10, 30, 60 (consider HUS in 1st 24 hrs in very sick ELBW infants)

Grade	Head US Findings
I	Germinal Matrix Hemorrhage (GMH)
II	IVH without ventricular dilation
III	IVH with ventricular dilation
IV	Grade III with parenchymal hemorrhage

Retinopathy of Prematurity (ROP) Screening

Routine exams indicated for
- BW <1500
- GA < 30 6/7 wks
- Infants 1500-2000 grams or >31 wks, but with “unstable” clinical course (mechanical ventilation, exchange transfusion, TORCH, ECMO, etc.)

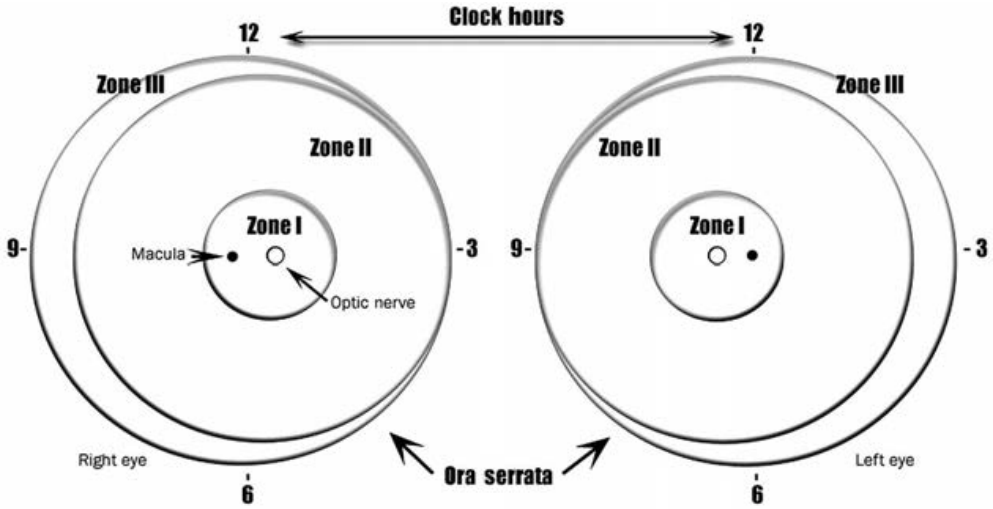
Timing

Generally:
- If GA at birth <28 weeks, then 1st exam at 31 weeks CGA
- If GA at birth ≥28 weeks, then 1st exam at 4 weeks chronologic age

Neonatal Neurology continued on next page →

Neonatal Neurology

Retinopathy of Prematurity (ROP) Screening cont.



Stages of Retinopathy of Prematurity (ROP)	
I	Mildly abnormal blood vessel growth. Many children who develop stage I improve with no treatment and
II	Moderately abnormal blood vessel growth. Many children who develop stage II improve with no treatment
III	Severely abnormal blood vessel growth. The abnormal blood vessels grow toward the center of the eye instead of following their normal growth pattern along the surface of the retina. Some infants who develop stage III improve with no treatment and eventually develop normal vision. However, when infants have a certain degree of Stage III and "plus disease" develops, treatment is considered. "Plus disease" means that the blood vessels of the retina have become enlarged and twisted, indicating a worsening of the disease. Treatment at this point has a good chance of preventing retinal detachment.
IV	Partially detached retina. Traction from the scar produced by bleeding, abnormal vessels pulls the retina
V	Completely detached retina and the end stage of the disease. If the eye is left alone at this stage, the baby

"Retinopathy of Prematurity (ROP)." National Eye Institute [NEI], of the U.S. National Institutes of Health. 28 May 2009 <http://www.nei.nih.gov/health/rop/#5>.

Therapeutic Cooling

- ***Protocols are site specific!
- Below are materials prepared by BWH
- BMC protocol varies and can be accessed via the BMC infonet

Hypothermia Eligibility Criteria	**Standard Eligibility Criteria:** • ≥ 34 weeks gestation • Any one of the following: ▪ Sentinel event prior to delivery ▪ Apgar score ≤ 5 at 10 minutes ▪ Requires PPV, intubation or CPR at 10 minutes ▪ pH ≤ 7.1 (from cord or blood gas within 60 minutes of birth) ▪ Abnormal base excess ≤ -10 mEq/L (from cord or blood gas within 60 minutes of birth)

Neonatal Neurology	
Therapeutic Cooling cont.	
Hypothermia Eligibility Criteria cont.	**Standard Eligibility Criteria:** • Any one of the following: ▪ Neonatal encephalopathy score ≥ 4 ▪ Seizure or clinical concern for seizure **Reasons to Exclude:** • Absolute contraindication: <34 weeks gestation • Relative contraindications: severe IUGR <1750 grams, severe congenital anomalies/genetic syndromes/known metabolic disorders, major intracranial hemorrhage, overwhelming sepsis, uncorrectable, clinically significant coagulopathy

Neonatal Neurology continued on next page →

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Therapeutic Hypothermia: System Overview

System	Overview of Management
Cardiovascular	1) Monitor with 3-lead EKG per routine. Expect bradycardia (< 100 bpm) when temperature < 34 °C 2) Vascular access o Establish peripheral IV access immediately (avoid scalp IVs) o Insert UVC (double lumen) if dependent on clinical scenario (For hypotension, arterial line monitoring is preferred prior to inotropic support being initiated)
Fluid and Electrolytes	1) Maintenance fluid o Total fluid volume of 60 ml/kg/day o Use Standard TPN @ 50 ml/kg/d with dextrose containing IV fluid, until custom TPN is available o Maintain GIR no less than 4 mg/kg/min at all times 2) After 24 hours of therapeutic hypothermia, if the infant is physiologically stable, the attending may initiate non-nutritive feeding of **10 mL/kg/day with mother's milk. This should not be advanced until after infant is rewarmed**
Respiratory	1) Ventilator Support – provide any respiratory support as needed o Avoid hypocapnia, and hyperoxia 2) Maintain air humidifier in normothermic range (37ºC)
Infectious Disease	1)Evaluate for Suspected Sepsis – start antibiotics after cultures obtained o Antibiotics should consist of Ampicillin and Cefotaxime (Cefepime may be used, if Cefotaxime not available)
Neurological	**1) Request Neurology Consultation, if not already requested** Sedation: maintain adequate sedation with Morphine. **The following guideline can only be deviated from with attending approval** o Loading dose 0.05 mg/kg IV (repeat PRN x 1 for shivering, severe irritability tachycardia HR > 120) o Start continuous infusion: 0.01 mg/kg/hr IV drip. DO NOT INCREASE THE INFUSION RATE o Reduce rate to 0.005 mg/kg/hr after 12 hours o Avoid Benzodiazepines for distress 2) Neuromonitoring: o Obtain full channel EEG on admission (to be ordered stat by neurology) o Continue full channel EEG for 24 hours or longer if seizures detected ▪ If no seizures and EEG recording considered low risk, may switch to aEEG after 24 hours (refer to aEEG CPG for details) o Neuromonitoring (either EEG or aEEG) should be continued until 6 hours after rewarming completed 3) Seizure control (Refer to Neonatal Seizure CPG for further details) o **1st choice agent for treating seizures is** Phenobarbital • Load: 20 mg/kg IV; repeat if seizures persist 20 minutes after load complete • Check serum levels 2-12 hours after load o If 2nd agent required: Fosphenytoin 20 mg/kg load o If 3rd agent required: Midazolam – load with 0.05 mg/kg IV and then infusion of 0.15 mg/kg/hour for 12 hours, taper over another 12-24 hours 4) Cranial ultrasound imaging should be ordered STAT (But do not need to wait for HUS to start therapeutic hypothermia) 5) MR imaging (NICU MRI Guidelines) ▪ If considering re-direction of care or early Exit, consider a MRI at 24-48 hours o Routine MRI – HIE protocol on DOL #4 (after re-warming) o Follow-up MRI on/after DOL #10- #21 6) Complete and document Neonatal Encephalopathy Neurological Examination at least once daily during hypothermia and re-warming, and at discharge
Skin	1) Monitor for subcutaneous fat necrosis (erythema, purple color, painful nodules, especially on the back and buttocks). May occur during hypothermia or after rewarming 2) If present monitor for hypercalcemia
Laboratory/ blood work	1) Lab schedule should be determined based on assessment of the infant's condition and evaluated daily and as needed- below is a **suggested lab plan**: o On admission: Blood gas, lactate, CBC, PT, PTT, INR, Fibrinogen, blood cx o 6 hours: BMP, Mg, ALT, AST o 24 h: CBC, PT, PTT, INR, Fibrinogen, BMP, Mg, P, ALT, AST o Daily BMP o Phenobarbital levels (only if patient was loaded for clinical seizures)

BRIGHAM HEALTH
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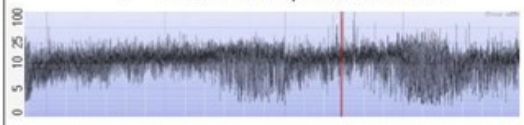
Department of Pediatric Newborn Medicine

New England Neonatal aEEG
and Neuroimaging Workshop

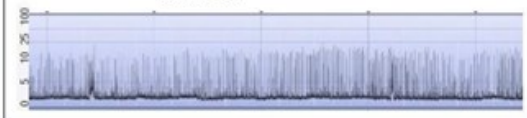
A- Background Pattern:

- **Continuous (C):**
  - lower amplitude > 5 mcV
  - maximum amplitude > 10 mcV

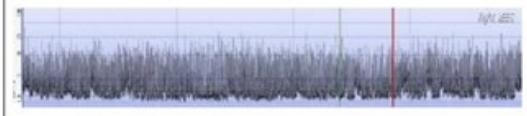


- **Discontinuous (DC):**
  - lower amplitude < 5 mcV
  - maximum amplitude > 10 mcV

- **Burst-suppression (BS):**
  - minimum amplitude without variability at ≤ 2 mcV and bursts with amplitude >25 mcV



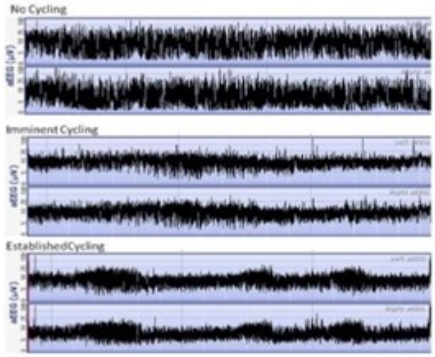
- **Low voltage (LV):**
  - lower amplitude < 5 mcV
  - maximum amplitude <10 mcV



- **Inactive, flat (FT):**
  - primarily inactive (isoelectric tracing) background < 5 mcV

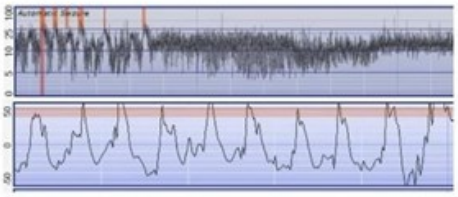
B- Cycling;

1. **No Cycling**
2. **Imminent Cycling:** Some, but not fully developed, cyclic variation of the lower amplitude
3. **Established Cycling:** Clearly identifiable sinusoidal variations between discontinuous and more continuous background activity, with cycle duration >20 min.

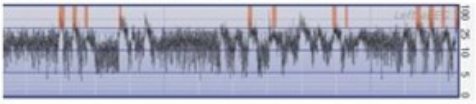


C- Seizures

1- **Seizures:** an abrupt, transient, sharp rise in the lower margin, often accompanied by a smaller rise in the upper margin, with narrowing of the bandwidth. This has to be associated with evolving, repetitive waveforms hat gradually build up and then decline in frequency, morphology, or amplitude on cEEG



2- **Status epilepticus:** Continuously ongoing seizure activity for >30 minutes.



Hypothermia Eligibility Criteria

Standard Eligibility Criteria	Present
A. ≥34 weeks' gestation	☐
B. Any one of the following	
a. Sentinel event prior to delivery	☐
b. Apgar score ≤ 5 at 10 min	☐
c. Requires PPV, Intubation or CPR at 10 min	☐
d. pH ≤ 7.1 (from cord or blood gas within 60 min of birth)	☐
e. Abnormal Base Excess ≤ - 10 mEq/L (from cord or blood gas within 60 min of birth)	☐
C. Any one of the following	
a. Neonatal Encephalopathy Scale Exam Score ≥4	☐
b. Seizure or clinical concern for seizure	☐

Reason to Exclude	Present
1. Absolute Contraindication (<34 weeks Gestation)	☐
2. Relative Contraindication (Severe IUGR <1750 gm, Severe congenital anomalies/genetic syndromes/known metabolic disorders, Major intracranial hemorrhage, Overwhelming sepsis, Uncorrectable, clinically relevant coagulopathy)	☐

All standard Criteria present- (A+B+C) Yes ☐ No ☐

If Yes and no reason to Exclude- **Immediately start Hypothermia Protocol** (Passively cool until active hypothermia initiated)

Evaluation for Hypothermia

Required for All Evaluated	**Performed**
1. Post-natal blood gas (<60 min from birth)	☐
2. Neonatal Encephalopathy Scale Exam (Repeat at set intervals if <4)	☐
Exam 1 ☐ Exam 2 ☐ Exam 3 ☐ Exam 4 ☐	
3. aEEG monitoring	☐
4. Direct communication of decision to treat or not to treat with;	☐
Family ☐ Obstetrical Team ☐	
5. All components of assessment documented in patients' medical record	☐

Considered for All Evaluated

Neurology Consult (Mandatory if encephalopathic, queried seizures, or decide to actively/passively cool) ☐

Encephalopathy Exam and aEEG Assessment

Neonatal Encephalopathy Scale Exam

Repeated exams required for patients being evaluated, and initial Score <4

a. Exam 1 (30 min after birth/admission) Score_____
b. Exam 2 (1 hour after Exam 1) Score_____
c. Exam 3 (1 hour after Exam 2) Score_____
d. Exam 4 (5 hours after birth) Score _____

Neonatal Encephalopathy Scale Score ≥4 at any time point Yes ☐ No ☐

aEEG Assessment

	Abnormal	Normal
Lower Margin	< 5 µV ☐	> 5 µV ☐
Upper Margin	< 10 µV ☐	>10 µV ☐
Cycling	Absent ☐	Present ☐
Seizures	Present ☐	Absent ☐

aEEG Pattern‡

CNV ☐ DNV ☐ BS ☐ LV ☐ FT ☐

‡Patterns Defined in EEG Neuro-monitoring in the NICU CPG, and Laminated Cards on aEEGs

Findings from Evaluation

1. Does infant meet all **standard criteria**	Yes ☐	No ☐
2. Does the Infant have an **encephalopathy score ≥ 4**	Yes ☐	No ☐
3. Does the Infant have an **abnormal aEEG**	Yes ☐	No ☐
4. (If consulted)- Does Neurology recommend treatment	Yes ☐	No ☐
5. Is there a **reason to exclude** infant	No ☐	Yes ☐

Initiate Therapeutic Hypothermia Yes ☐ No ☐

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Neonatal Encephalopathy Examination Scoring Sheet

Date	1 Time	2 Time	3 Time	4 Time	
1- Observe spontaneous activity	0 2 3	0 2 3	0 2 3	0 2 3	Normal Decreased= decreased frequency or amplitude of spontaneous facial and extremity movements Absent
2- Observe for Heart rate	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3	Normal Tachycardia = resting HR 160-180. Only occasionally decreased to 120 Bradycardia= resting HR 80-90. Only occasionally increases to 120 Variable= resting HR varies considerably without a consistent baseline
3- Observe for respiration	0 2 3	0 2 3	0 2 3	0 2 3	Normal Periodic Breathing= 3 or more respiratory pauses ≥ 3 sec separated by normal breathing and < 20 sec. Often associated with shallow breathing Apnea= no breathing for ≥ 20 sec or < 20sec with HR changes or O2 desaturation
4- Observe for posture	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3	Normal **Mild Distal Flexion =** Fingers and toes in flexion, incomplete extension of fingers when stroked on dorsal surfaces. Thumbs flexed, adducted, opposed across palms "cortical thumb" **Strong Distal Flexion=** Fingers and toes in strong flexion, incomplete extension of fingers when stroked on dorsal surfaces. Thumbs flexed, adducted, opposed across palms "cortical thumb" Decerebrate= Head, neck and back are arched in extension (opithotonus), elbows are extended, wrists are pronated and hips are abducted.
5- Observe for level for consciousness	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3	**<u>Use Auditory stimulation, Visual stimulation and Tactile stimulation to assess level of consciousness</u>** Normal 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 Irritable — lowered threshold with excessive responses to all stimulus types. Can be seen with varied states including hyperalert, lethargy or obtundations Lethargic — Slightly delayed but complete response to stimuli with slightly increased threshold for eliciting responses and decreased spontaneous activity Obtunded — Delayed and incomplete response with marked increased threshold to all sensory stimuli and little or no motor activity. Stupor — No spontaneous eye opening to tactile stimulation elicits poorly sustained eye opening. Responds only to strong noxious stimuli. Absent gag and cornel reflex Coma — No eye opening with vigorous tactile stimulation

6- Tone Assessment	0	0	0	0	Normal
	2	2	2	2	Hypotonic= Focal or generalized decreased resistance to passive movement. Associated with greater extension of extremities than normal
					Flaccid= "Flat on the mat" appearance. Maybe associated with frog-leg posturing with arm and hips/legs lying in abduction\
	3	3	3	3	**A- Arm Recoil: Quickly extend (straighten) both arms; put next to body. Count to two. Let go. Repeat 3 times.**
					Normal: Arms flexes and remains flexed **Hypotonia:**
					B- Leg Recoil: Take both ankles, bend hips+ knee. Quickly extend when infant not pushing. Let go. Repeat 3 times.
					Normal: Complete Fast Flexion **Hypotonia:**
					C- **Vertical Suspension: Hold baby upright by placing hands under axillae**
					Normal: No Slip through **Hypotonia:** Slip Through
					D- **Head Lag: Pull baby to sit by the wrists and support head slightly.**
					Normal: Lifts head in line with body **Hypotonia:**
					E- Ventral Suspension: Hold baby horizontal under the belly. Look at posture of back, arms, legs and head.
					Normal: Back straight, head in line with body, limb flexed **Hypotonia:**
7- Reflexes					**a- Sucking reflex**
	0	0	0	0	Normal
	1	1	1	1	Weak
	2	2	2	2	Weak/Uncoordinated
	3	3	3	3	Absent
					b- Moro Reflex
	0	0	0	0	Normal
	1	1	1	1	Exaggerated
	2	2	2	2	Weak/Incomplete
	3	3	3	3	Absent
					c- Light Reflex
	0	0	0	0	Normal
	1	1	1	1	Dilated
	2	2	2	2	Constricted
	3	3	3	3	Unequal/ Fixed dilated
Total NE Score					