PEDIATRIC NEWBORN MEDICINE CLINICAL PRACTICE GUIDELINES

Therapeutic Hypothermia

Implementation Date: March 23, 2015
Current Version: April 12, 2017

Clinical Practice Guideline: Therapeutic Hypothermia Guidelines

Points of emphasis/Primary changes in practice:
1. GA for inclusion is ≥ 34 wks
2. Eligibility criteria chart modified-Base excess no longer a separate criterion in eligibility chart. Is now a sub-criterion with other perinatal risks, and new threshold of ≤ - 10 mEq/L.
3. Recommend requesting cord gas in delivery and a baby blood gas within one hour of delivery if cooling is a possibility
4. Absolute exclusion criteria for GA changed to < 34 wks
5. Added information about drawing coags from a heparinized line and need to coordinate with lab for timing in addition to thresholds to treat.
6. Revised gut priming can be initiated after a minimum of 24 hrs of cooling, physiologically stable with no end organ compromise and at the discretion of the attending at 10 ml/kg/d.
7. Standard TPN is to be initiated until custom TPN is available
8. Passive cooling target temperature changed to 33.5 °C. Algorithm for re-warming a passively cooled infant added as attachment
9. Monitor for subcutaneous fat necrosis (SCFN) and follow calcium levels closely
10. Modifying the aEEG/cEEG guidelines

Rationale for change:
1. To be in-keeping with CRICO recommendations
2. To help evaluate need for cooling
3. To prevent wasting of blood if lab unable to perform test at that time
4. To assure physiological stability
5. To provide immediate source of protein
6. To standardize re-warming passively cooled infants who have never been actively cooled
7. Subcutaneous fat necrosis (SCFN) is a rare entity that appears in term or post-term infants with predisposing risk factors including therapeutic hypothermia.

Questions? Please contact: Department of Pediatric Newborn Medicine

Clinical Guideline Name	Therapeutic Hypothermia
Effective Date	3/24/2015
Revised Date	12/8/2015, 04/12/17
Team Leader(s)	Department of Pediatric Newborn Medicine Chair & NICU Clinical Nurse Educator
Approved By	Department of Pediatric Newborn Medicine Clinical Practice Council 3/12/15, 12/8/15 CWN SPP 3/11/15, 01/13/2016 BWH SPP Steering 3/18/15 Nurse Executive Board/CNO 3/25/15
Keywords	Therapeutic Hypothermia, Encephalopathy, Newborn Seizures, Passive Cooling, Passive Re-warming, Infant Cooling

This is a clinical practice guideline. While the guideline is useful in approaching therapeutic hypothermia, clinical judgment and / or new evidence may favor an alternative plan of care, the rationale for which should be documented in the medical record.

I. Purpose

To provide therapeutic hypothermia guidelines for NICU infants ≥34 weeks postmenstrual age with evidence of encephalopathy /or perinatal acidemia and/or resuscitation and/or a sentinel event.

II. All CPGs will relay on the NICU Nursing Standards of Care. All relevant nursing PPGs are listed below.

NICU H.3 Therapeutic Hypothermia Using Either the Criticool ® System or Blanketrol ® III System

WNH M.1 Administration of Medications to Infants

III. Scope

These guidelines establish an approach to therapeutic hypothermia for a specific population of infants cared for in the Newborn Intensive Care Unit as outlined above.

IV. Guidelines

1. Infant eligibility:

A. ≥ 34 weeks gestation

AND

B. Any one of the following:
   - **1)** Sentinel event prior to delivery such as uterine rupture, profound bradycardia or cord prolapse
   - **2)** Low Apgar scores → ≤ 5 at 10 minutes of life
   - **3)** Prolonged resuscitation at birth → chest compressions and/or intubation and/or mask ventilation at 10 minutes
   - **4)** Severe acidosis → pH ≤ 7.1 from cord or patient blood gas within 60 minutes of birth
   - **5)** Abnormal Base Excess → ≤ - 10 mEq/L from cord or patient blood gas within 60 minutes of birth

AND

C. Any one of the following:
   - **1)** Seizure or any clinical event concerning for seizure
   - **2)** Neonatal encephalopathy (defined as the presence of abnormal neurological behavior on the Neonatal Encephalopathy Scale of ≥4)

NEONATAL ENCEPHALOPATHY SCALE

Stage	Normal (0 points each)	Mild Stage 1 (1 point each)	Moderate/Stage 2 (2 points each)	Severe/Stage 3 (3 points each)
1. Level of Consciousness	Normal **0**	Hyper-alert/Irritable **1**	Lethargic/Obtunded **2**	Stupor/Coma **3**
2. Spontaneous Activity	Normal **0**	Normal **0**	Decreased **2**	Absent **3**
3. Muscle Tone	Normal **0**	Normal **0**	Mild Hypotonia **2**	Flaccid **3**
4. Posture	Normal **0**	Mild Distal Flexion **1**	Strong Distal Flexion **2**	Decerebrate **3**
5. Primitive Reflexes				
Suck	Normal **0**	Weak **1**	Weak/Absent **2**	Absent **3**
Moro	Normal **0**	Strong/Low Threshold **1**	Weak/Incomplete/ High Threshold **2**	Absent **3**
6. Autonomic Function				
Pupils	Normal **0**	Mydriasis **1**	Miosis **2**	Unequal/Fixed/ Dilated/Poor Reflex **3**
Heart Rate	Normal **0**	Tachycardia **1**	Bradycardia **2**	Variable **3**
Respirations	Normal **0**	Normal **0**	Periodic Breathing **2**	Apnea **3**
Total Score	_____	_____	_____	_____

2. **Identification of Infants:**

A. Eligible patients may be identified by Labor & Delivery or Pediatrics staff at the time of resuscitation or based on cord blood gases and/or initial newborn blood gases. Eligible patients should be identified and discussed for possible therapeutic hypothermia therapy **as soon as possible after birth.**
Request cord gas in Labor & Delivery if not already obtained. A cord gas should be requested if there are any clinical concerns.

B. A complete evaluation to determine the need to commence therapeutic hypothermia should be completed and documented (result and timing) by Neonatology attending and/or fellow as soon as possible following admission on any patient meeting at least one objective criterion (*e.g.,* Apgar score, sentinel event, cord pH, or cord BE) for therapeutic hypothermia and at least one finding consistent with encephalopathy. A complete assessment should include:

- **i.** A post-natal blood gas within 1 hour of birth.
- **ii.** Scored using the Neonatal Encephalopathy examination score, on admission and repeated over the coming hours.
- **iii.** aEEG monitoring

C. If patient scores at <4 on neonatal encephalopathy examination, repeat examination with documentation in one hour or sooner as needed; continue to repeat examination as needed based upon results and course (Result and timing of all exams should be documented in EMR) .

D. Therapeutic hypothermia to be initiated per protocol **as soon as possible after patient meets entry criteria** and should be considered as proven to be therapeutic only if commenced in the first 6 hours of life. Evidence now demonstrates that earlier is better. If the patient is >6 hours then hypothermia may be commenced at attending decision discretion as there is no current trial data to support benefit. However, with low risk it would be reasonable to support this therapy in the 12 hour window.

E. Other infants that may benefit from therapeutic hypothermia, such as sudden infant collapse on the postnatal ward, and should be considered with the NICU Attending on a patient by patient basis.

F. The decision to either commence or not commence therapeutic hypothermia should be carefully documented in the medical chart. This documentation should include;

a. The findings and timing at which performed, of the individual components of the evaluation (lab results, encephalopathy score, aEEG findings).
b. Clear documentation that decision was communicated with both the family of the infant, and the obstetrician of record.

3. **Exclusion Criteria for Therapeutic Hypothermia:**

A. Absolute Exclusion Criteria:
- Gestational age less than 34 wks

B. Relative Exclusion Criteria(at discretion of attending physician)**:**
- Severe IUGR <1750grams
- Severe congenital anomalies / genetic syndromes / known metabolic disorders
- Major intracranial hemorrhage
- Overwhelming sepsis
- Uncorrectable, clinically relevant coagulopathy

V. Management of In-born Infants Eligible for Therapeutic Hypothermia

1. For eligibility criteria, refer to page 1 (Section III.) of this document.
2. Minimum time for complete evaluation for hypothermia is 6 hours. If delivery/admission team, consider that the infant is at high risk for significant encephalopathy, or if the infant is transferred for evaluation from an external site, the infant should be admitted to the NICU for a minimum of 18-24 hours to monitor.
3. Therapeutic hypothermia should be initiated as soon as a patient meets entry criteria.
4. Consult Neurology Service for review of infant and EEG monitoring for seizures. Therapeutic hypothermia should be started immediately; before the neurology service review, cranial ultrasound and/or EEG monitoring is established.
5. Parental consent is NOT required.
6. Passive cooling:
- **A.** Initiate as soon as infant meets entry criteria for therapeutic hypothermia which will often be in Labor & Delivery i.e. turn off radiant warmers and/or transport isolette heater.
- **B.** Keep baby draped with light bed sheet whenever possible.
- **C.** **Target core (rectal) temp is 33.5˚C for passive cooling.** Use continuous rectal temperature monitoring or q 15-30 minute intermittent rectal thermometer for close monitoring.
  Caution: Cooled babies have depressed metabolism, so generate less heat. If baby has never been warmed they are easily over-cooled, even passively.
- **D.** Once rectal temp falls to 34˚C, have external heat sources available.
  1) If core temp falls < 33.5˚C, turn on heat source to lowest settings.
  2) If core temperature < 33˚C, use a warmed blanket over baby's chest/abdomen until core temperature reaches 33˚C and then remove the blanket.
- **E.** Slowly adjust heat sources as needed to achieve target temperature.
- **F.** For re-warming passively cooled infants see algorithm at end of clinical practice guideline.

G. If passively cooled infant does not meet criteria for active therapeutic hypothermia, document that passive cooling was initiated and infant did not meet criteria for active therapeutic hypothermia (including reason why active therapeutic hypothermia was not done).

7. Procedure to be followed after admission to the NICU:

A. Place infant on the therapeutic hypothermia system and follow guidelines for connecting and starting the device (refer to Therapeutic Hypothermia Manual with specific therapeutic hypothermia unit and Nursing Policy **NICU H.3** Therapeutic Hypothermia Using the CritiCool® or Blanketrol® System

B. Scenarios for setting target temperature:

1) The target rectal temperature during active cooling is 33.5°C.

2) If infant has core temperature of 31-37°C, set target temperature to 33.5°C.

3) If core temperature is <31°C, set target temperature at 1°C above actual core temperature. Target temperature should be reached in ~30 min. Keep increasing target temperature in increments of ~1°C every 30 minutes until core temperature is >32°C and then set target temperature to 33.5°C.

Please note: The blanket remains warm to touch and this is normal as it tries to maintain the infant's temperature when the infant may have a low body temperature.

8. Secure vascular access

A. Establish peripheral IV access immediately (avoid scalp IVs due to need for EEG monitoring).
NICU I.2 Intravenous Angiocatheter Insertion

B. Insert UVC (double lumen) if possible.

C. Do not delay the commencement of therapeutic hypothermia for placement of umbilical lines.

D. Arterial line (e.g., UAC or radial arterial line) – for continuous monitoring and sampling if required is to be discussed with NICU attending based on the severity of the illness in the infant.
NICU C.4 Use and Care of Central Venous Catheters (CVC) and Peripherally Inserted Central Catheters (PICC)
NICU C.5 Assisting with Umbilical Vessel (Arterial and/or Venous) Catheterization and/or Peripheral Arterial Line Placement and Removal

9. Maintain adequate sedation

A. Keep patients adequately sedated to avoid cold stress. Most trials did not use ANY sedation alongside hypothermia therapy. Indirect evidence supports that modest sedation alongside hypothermia improves outcome.

B. NPASS as sedation evaluation has not been validated in this population. Use clinical judgment along with medical/nursing team to keep infant comfortable.

C. Infant can be touched and when possible held by family to assist in soothing infant.

D. Morphine is drug of choice - **this guideline can only be deviated from with attending approval**

1) Loading dose 0.05 mg/kg IV (repeat PRN x 1 for shivering, severe irritability tachycardia HR > 120). Note that tachycardia may also be secondary to poor cardiac function, intravascular depletion, sepsis, or other etiologies so additional sedation for tachycardia should be taken into context. Minimize bolus use to prevent the need for intubation due to sedation. Non-pharmacological means of calming should be tried.
2) Start continuous infusion: 0.01 mg/kg/hr IV drip. DO NOT INCREASE THE INFUSION RATE.
3) Reduce rate to 0.005 mg/kg/hr after 12 hours.
4) **AVOID** over dosage of morphine which will produce respiratory depression which can necessitate intubation.
5) Avoid Benzodiazepines for distress.

10. Laboratory/blood work

A. Lab schedule should be determined based on assessment of the infant's condition and evaluated daily and as needed.

Suggested blood work:

- On admission: Blood gas, lactate, CBC, PT, PTT, INR, Fibrinogen, blood cx
- 6 hours: BMP, Mg, ALT, AST
- 24 h: CBC, PT, PTT, INR, Fibrinogen, BMP, Mg, P, ALT, AST
- Daily BMP

NICU B.1 Arterial and Venous Blood Drawing

B. Blood gases

1) In patients requiring prolonged resuscitation, or if there are any clinical concerns (e.g. Any sentinel event at delivery, presence of a Category 2 or 3 trace, delivery by emergency LSCS or instrumental delivery, infant required PPV or **low Apgar score**) send cord blood gases (UA and UV) if available
    - Send initial patient blood gas with lactate (within 1st hour of life), then check regularly as judged appropriate based on the clinical condition of the infant.
    - **NICU B.6** Blood Gas Sampling

C. Electrolytes and chemistries: levels may fluctuate with therapeutic hypothermia. These should be checked within the first 6 hours of starting TH and repeated as guided by the attending physician based on the clinical condition of the infant. Use clinical judgment as many levels will self-correct over the next 24-48 hours without intervention.

1) Sodium: low sodium may result if patient has ATN/renal injury and poor urine output.
2) Potassium levels may rise or fall with therapeutic hypothermia
3) Calcium levels may fall with therapeutic hypothermia, or rise in the presence of SCFN.
    - Treatment of severe hypercalcemia includes hyperhydration and intravenous furosemide. High-dose corticosteriods may also be part of the medical management of an infant with hypercalcemia
4) Magnesium levels may fall with therapeutic hypothermia
    - Caution: High magnesium levels may cause hypotension
5) Glucose levels may rise or fall with therapeutic hypothermia
    - Requires close monitoring – on admission and hourly until stable X2, then Q12h X2 and prn with any concerns or fluid changes.

D. CBC with platelets

1) Monitor for thrombocytopenia.
2) Due to concomitant thrombocytopenia with hypothermia and concern for cerebral ischemia consider lower threshold for platelet transfusion at <50,000 to transfuse rather than traditional platelet threshold for transfusion of <20,000. If active bleeding is present, then transfusion may be indicated before or despite the platelet values.

E. Micro

1) Blood cultures
2) Other sources as clinically indicated
3) Start antibiotics as clinically indicated

F. Other labs:

1) PT/PTT/INR should be checked as soon as possible in center on arrival (if coagulation studies are obtained via a heparinized line then note "heparin absorbed" on lab requisition and check with lab for timing to perform test).
    - If coagulation studies (e.g. PT/PTT/INR) are drawn from the UVC and the PTT comes back prolonged (as expected due to heparin), a hepabsorb PTT does **not need to be sent** as a matter of routine practice, unless specifically requested by the attending. This test is not available 24/7 and also requires 2.7 mls of blood.
    - All the other clinical information available along with the other laboratories (e.g. CBC/PT/INR/Fibrinogen) can be used to make a determination about factor replacement rather than sending the

hepasorb test. If there is a specific clinical concerns about the coagulation cascade that requires accurate determination of the PTT, then hepasorb PTT or, preferably, a blood sample drawn peripherally that is not contaminated with heparin can be sent.

2) BUN and Creatinine (after 6 hours of life)
3) AST and ALT (after 6-24 hours of life)
4) Serum lactate at initial blood gas if possible or as soon as possible on arrival
5) Phenobarbital levels (only if patient was loaded for clinical seizures)

Medical Management Guidelines by Systems:

A. Cardiovascular

1) Blood pressure management – continuous arterial line monitoring preferred prior to any inotropic support being initiated
   - Maintain blood pressure in normal range, despite bradycardia
   - Treat hypovolemia with volume administration as needed
   - Support blood pressure with fluids or pressors only if indicated
     - Normal Saline – 10 mL/kg IV fluid bolus
     - Continuous IV pressor infusions:
       - Dopamine (1st choice agent) dopamine dag
       - Consider norepinephrine for poor vascular tone and PPHN
       - Consider milrinone for cardiac dysfunction and PPHN
2) Heart rate
   - Expect bradycardia (< 100 bpm) when temperature < 34 ^{o}C
   - Monitor with 3-lead EKG per routine
   - Deep bradycardia (< 80 bpm)
     - May be tolerated, if blood pressure is maintained adequately
     - Raising rectal temperature to 34 ^{o}C alone may be adequate
   - Monitor for arrhythmias and consider an EKG and electrolytes, calcium and magnesium. Infants may have prolonged QTc and this should be monitored if severe bradycardia is present.

B. Fluid and Electrolytes

- NPO is the standard during evaluation of and active therapeutic hypothermia. However, if the infant is physiologically stable with no end organ compromise, at the attending discretion and after the 1st 24 hours of therapeutic hypothermia, minimal enteral nutrition may be provided at up to **10 mL/kg/day**. Only mother's milk may be used (i.e. no formula or donor milk) until infant is re-warmed. Feedings may not be advanced beyond **10 mL/kg/day** until infant is fully re-warmed.

- Start IV maintenance fluids: Initiate Standard TPN at 60 mL/kg/day until custom TPN is available. Discontinue Standard TPN and increase concentration of dextrose if patient requires total fluids < 60 mL/kg/day before custom TPN available or is hypoglycemic. Maintain GIR no less than 4-5 mg/kg/min at all times. Adjust GIR as needed with custom TPN.
- Monitor and maintain electrolytes within normal limits. Frequency to be determined by medical team based on severity of infant illness (See suggested lab work and schedule in section 10. A. above).
- Management of Acidosis –**Avoid base replacement therapy** if circulation is re-established and patient can self correct over time. Acidosis may take up to three days to fully correct.
- Treat hypovolemia with volume administration as needed
  - Normal Saline – 10 mL/kg IV
  - Packed Red Blood Cells (+/-plasma) – if blood loss is etiology
- If worsening acidosis or cardiovascular collapse with BE ≥ -12 consider:
  - Normal Saline – 10 mL/kg IV

C. Respiratory

1) Ventilator Support – provide any respiratory support as needed
   - Avoid hypocapnia
     - Therapeutic hypothermia can ↓ pCO2.
     - Maintain blood gas pCO2 goal: 45-50 mmHg
   - Avoid hyperoxia
     - Maintain Oxygen saturations according to CPG Target O2 Saturations for Infants in the Neonatal Intensive Care Unit
     - PaO2 should be < 100mmHg
     - *Caveat: Hypothermia could be associated with pulmonary hypertension. Manage accordingly CPG for* Diagnosis and Management of the Infant with Suspected or Known Pulmonary Hypertension of the Newborn
- Maintain air humidifier in normothermic range (37ºC)

D. Infectious Disease

- Evaluation for Suspected Sepsis – start antibiotics after cultures obtained

For infants ≥35 weeks:

- Ampicillin: 100 mg/kg/day IV q8 hrs
- Cefotaxime: 50mg/kg/dose IV q8 hrs (or Cefepime 50 mg/kg/dose IV Q 12 h if Cefotaxime not available)

For infants 34 – 34 6/7:

- Ampicillin: 100 mg/kg/day IV q12 hrs
- Cefotaxime: 50mg/kg/dose IV q12 hrs (or Cefepime 50 mg/kg/dose IV Q 12 h if Cefotaxime not available)

For all infants:

- Consider obtaining CSF sample for investigation if suspicion of meningitis or if blood culture positive or unexplained encephalopathy. (If coagulopathy present correct first)

E. Neurological

1) **Neurology Consultation**
2) Sedation: maintain adequate sedation - see morphine dosing above.
3) Neuromonitoring:
   - Obtain clinical full channel EEG on admission (to be ordered stat by neurology resident)
   - Continue video EEG recording for 24 hours or longer if seizures detected
     - If no seizures and EEG recording considered low risk, may switch from cEEG to aEEG after 24 hours (refer to aEEG CPG for details). For further details refer to aEEG CPG.
   - Continue EEG (or aEEG) monitoring until 6 hours after complete rewarming)
4) Seizure control
   - **1st choice agent for treating seizures is Phenobarbital** – if clinical events noted then consult with neurology based on review of simultaneous EEG
   - Load: 20 mg/kg IV; repeat if seizures persist 20 minutes after load complete.
   - Check serum levels 2-12 hours after load
   - If 2nd agent required: Fosphenytoin 20 mg/kg load
   - 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
   - (Refer to Neonatal Seizure CPG for further details)
5) Cranial ultrasound imaging should be ordered STAT. However it is not required prior to the initiation of hypothermia therapy, and therapy should not be delayed pending an ultrasound.
6) MR imaging

   NICU MRI Guidelines
   - If severely encephalopathic with severe EEG depression and signs of brain stem injury, consider a MRI at 24-48 hours (if redirection of care is being considered)
   - Routine MRI – HIE protocol on DOL #4 (after re-warming)
   - Follow-up MRI on/after DOL #10- #21
7) Complete and document Neonatal Encephalopathy Neurological Examination at least once daily during hypothermia and re-warming, and at discharge.

F. Skin

A. Monitor for erythema, purple color, painful nodules (especially on the back and buttocks) both during TH and following rewarming that may indicate subcutaneous fat necrosis (incidence 2-4/1,000). These lesions usually appear during the first weeks of life and resolve in weeks or months

B. Infant may be uncomfortable over affected skin region. If noted requires:
   a. Separation of affected skin from cooling pod by gauze or cloth;
   b. Adequate analgesia including local treatments such as heated blanket; (after rewarming)
   c. Monitor for hypercalcemia at initial concern and then at least each week for 6 weeks. Following this, if an infant shows poor feeding or lethargy a further calcium should be checked as hypercalcemia can be noted up to 3 - 6 months following fat necrosis.

G. Re-warming

A. Re-warming a passively cooled infant who has never been actively cooled occurs over 2 hours. **See algorithm on Page 16**.

B. Re-warming the actively cooled infant begins after 72 hours of therapeutic hypothermia and is accomplished over a 15 hour period.

C. Increase core temperature setting by 0.2°C every hour until infant's core temperature reaches 36.5° C.

D. Monitor neurological status closely (every 2-4 hours) during re-warming

E. Turn therapeutic hypothermia machine off once core temperature reaches 36.5 °C.

F. The rectal temperature probe may be removed.

G. EEG or aEEG monitoring should be continued until 6 hours after rewarming.

H. Exit Criteria

A. If the infant had mild encephalopathy or minimal concerns by the clinical team then the infant can be considered at 24 hours of age for exit criteria. These criteria include:
   1) Mild encephalopathy at admission
   2) Absence of significant abnormalities on the full channel EEG at 24 hours of age with no previous EEG seizures and normal cyclicity
   3) Normal neurological examination by two independent examiners (morphine considered)
   4) Negative MRI scan at 24-48 hours of life with no lactate peak in MRS and no restriction on diffusion weighted imaging.

B. If the above criteria are fulfilled, then the infant can begin re-warming. Follow same protocol for re-warming the actively cooled infant.

VI. Management of Out-born Infants Eligible for Therapeutic Hypothermia

NICU T.4 Transfer to BWH from an Outside Hospital

1. Screening criteria to be used when taking a transport call for out-born infants:

A. Infants ≥ 34 weeks gestational age

AND

B. Any one of the following:

- **a.** Sentinel event prior to delivery such as uterine rupture, profound bradycardia or cord prolapse
- **b.** Low Apgar scores → ≤ 5 at 10 minutes of life
- **c.** Prolonged resuscitation at birth → chest compressions and/or intubation and/or mask ventilation at 10 minutes
- **d.** Severe acidosis → pH ≤ 7.1 from cord or patient blood gas within 60 minutes of birth
- **e.** Abnormal Base Excess → ≤ - 10 mEq/L from cord or patient blood gas within 60 minutes of birth

AND

C. Any one of the following:

- **a.** Seizure or any clinical event concerning for seizure
- **b. Encephalopathy (any one of the following when an examination cannot be undertaken on the prescribed sheet):**
  1) Hyper alert
  2) Irritable
  3) Lethargy or obtunded
  4) Stupor or coma
  5) Decreased spontaneous activity
  6) Hypotonia or flaccid
  7) Decerebrate posturing
  8) Absent or weak suck
  9) Abnormal pupillary reflex
  10) Abnormal Moro reflex
  11) Persistent bradycardia/heart rate variability
  12) Periodic breathing or apnea

2. Eligible infants should receive PASSIVE COOLING ONLY with rectal temperature monitoring documented every 5-15 minutes. Eligible infants should NOT be actively cooled at outside hospital.

3. **CRITICAL IMPORTANCE:**
   Monitor core (rectal) temperature closely (continuous or intermittent)
   1) Continuous rectal temperature monitoring (preferred method if available)
   - Gently insert lubricated rectal probe to approx 6 cm, tape to thigh
   - Document temperature and vital signs every 15 minutes

   2) Intermittent rectal temperature checks (until transport team arrives)
   - Gently insert lubricated thermometer rectally ~2 cm
   - Document temperature and vital signs every 15 minutes

4. **Temperature Conversion Chart (˚C → ˚F)**
   °C to °F Conversion formula: °C = 5/9 x (°F-32)
   - **33.5˚C = 92.3˚F ←Target Temperature**

5. **Passive cooling:**
   H. **TURN OFF RADIANT WARMERS *or* TRANSPORT ISOLETTE HEATERS**
   I. Keep baby draped with light bed sheet whenever possible
   J. Target core (rectal) temp is 33.5˚C
   K. **Caution**: Cooled babies have depressed metabolism, so generate less heat. If baby has never been warmed they are easily over-cooled, even passively. Additionally, cooled babies will also have a lower resting heart rate, often in the 80-100 range when adequate core temperature is reached, and sometimes slightly lower. There is no risk associated with this low heart rate >60bpm.
   L. Once rectal temp falls to 34˚C, have external heat sources available
   3) If core temp falls < 33.5˚C, turn on external heat source (incubator or use warmer) to lowest settings
   4) If core temperature < 33˚C, use external heat source or warmed blanket over baby's chest/abdomen until core temperature reaches 33˚C and then remove the external heat source/blanket
   M. Slowly adjust heat sources as needed to achieve target temperature
   N. Continue close monitoring to prevent rapid re-warming
   O. If core temp rises > 35˚C, try opening isolette port(s), door or undraping
   P. Avoid overhead radiant warmers for heat source.

REFERENCES:

1. "The 2008 National Institute of Child Health Human Development Workshop Report on Electronic Fetal Monitoring: Update, Definitions, Interpretations, and Research Guidelines" by G.A. Macones et al. 2008, JOGN, 37, 510-515, OGN 112, p. 655.
2. Ambalavanan et al. Predicting Outcomes of Neonates Diagnosed With Hypoxemic-Ischemic Encephalopathy, Pediatrics, 2006
3. American Heart Association and American Academy of Pediatrics. Handbook for Neonatal Resuscitation Textbook, 6th ed. 2011. Washington, DC: AHA/AAP.
4. Austin et al. To cool or not to cool? Hypothermia treatment outside trial criteria, ADC-FNN, 2012
5. Azzopardi DV, Edwards AD, et al. Moderate Hypothermia to Treat Perinatal Asphyxial Encephalopathy. N Engl J Med 2009;361:1349-58
6. Bednarek et al. Impact of therapeutic hypothermia on MRI diffusion changes in neonatal encephalopathy, Neurology, 2012
7. Children's Hospital Boston, Neurology and Neonatal Intensive Care Unit Staff, Consultation, Spring 2014.
8. Curley, MAQ, RN, PhD, FAAN, Harris, SK PhD, Fraser Karen A., RN, Johnson, RA, RN, BSN, and Arnold JH., MD State Behavioral Scale (SBS) A Sedation Assessment Instrument for Infants and Young Children Supported on Mechanical Ventilation Pediatric Crit Care Med. 2006 March ; 7(2): 107–114.
9. Jacobs, S.E., Berg, M., Hunt, R., Taronow-Mordi, W.O., Inder, T. E. , and Davis, P.G. Cooling for newborns with hypoxic ischaemic encephalopathy (Review). The Cochrane Collaboration®, The Cochrane Library 2013, Issue 1.
10. Martinez-Biarge, M. et al. Antepartum and Intrapartum Factors Preceding Neonatal-Hypoxic Encephalopathy. Pediatrics 2013: 132; e952; originally published online September 9th, 2013.
11. Mather, A. M. et al. Hypothermia and Hypoxic Ischemic Encephalopathy: Guideline Development Using the Best Evidence. Neonatal Network, vol. 27, no. 4, July/August 2008, pp. 271-285.
12. Merrill, L. Therapeutic Hypothermia to Treat Hypoxic Ischemic Encephalopathy in Newborns – Implications for Nurses. Nursing For Women's Health. April/May 2012, pp. 127-134.
13. Shankaran, S. et al. Outcomes of Safety and Effectiveness in a Multicenter Randomized Controlled trial of Whole-Body Hypothermia for Neonatal Hypoxic Ischemic Encephalopathy. Pediatrics Volume 112, number 4, October 4, 2008. pp. 791-798.
14. Thoresen M. Supportive Care During Neuroprotective Hypothermia in the Term Newborn: Adverse Effects and Their Prevention. Clin Perinatol 2008; 35: 749-63.
15. van Laerhoven et al. Prognostic Tests in Term Neonates With Hypoxic-Ischemic Encephalopathy: A Systematic Review, Pediatrics, 2013
16. Zanelli, S. and Fairchild, K. Physiologic and Pharmacologic Effects of Hypothermia for Neonatal Hypoxic Ischemic Encephalopathy, Newborn & Infant Nursing Reviews, March 2009, volume a, number 1, pp. 10-17.
17. Perez Martinez, E et al. Treatment with bisphosphonates in severe hypercalcemia due to subcutaneous fat necrosis in an infant with hypoxic-ischemic encephalopathy. 2014 Jun;34(6):492-3.
18. Shumer DE, et al. Severe hypercalcaemia due to subcutaneous fat necrosis: presentation, management and complications.Arch Dis Child Fetal Neonatal Ed. 2014 Sep;99(5):F419-21.

Algorithm for Re-warming a Passively Cooled Infant

Goal is normothermia at 36.8C