

TREATMENT OF HYPOXIC ISCHEMIC ENCEPHALOPATHY WITH COOLING
Children's Hospital & Research Center Oakland Guideline
Revised 05-13-13 by P. Joe

SCREENING FOR POTENTIAL COOLING PATIENTS

Patients who are ≥ 35 weeks gestation are *potentially* eligible for cooling if they meet any of the following criteria:

- Apgar ≤ 6 at 10 minutes
- Need for ongoing respiratory support in the delivery room @ 10 minutes
- Seizure or other sign(s) of encephalopathy
- Cord blood gas (arterial or venous) with pH < 7.00 or Base Deficit > 10 mmol/L
- History of a "perinatal event" (abruption, cord accident, etc.)

Patients who meet any of the above criteria should have the following performed immediately:

- Blood gas at ≤ 1 hr of age (on the patient, not just the cord blood)
- Careful neurologic exam performed by neonatologist or hospitalist, including Sarnat score (included in this document)
- Call Children's neonatologist to discuss whether the patient is a potential cooling candidate, and whether passive cooling should be started. If there are any questions, consult with the ECMO neonatologist on call.

ELIGIBILITY CRITERIA FOR COOLING

We now consider patients eligible for cooling if they meet ALL of the following 3 criteria:

Age Criteria (both of two)

- Gestational age ≥ 35 weeks gestation
- Less than 6 hrs of age and can be started on active cooling within 6 hrs OR received passive cooling at less than 6 hrs of age and can be started on active cooling within 8 hrs of age

Physiologic Criteria (either of two)

- pH ≤ 7.0 OR base deficit ≥ 16 mEq/L on postnatal blood gas (cord or patient) at ≤ 1 hr of age
- pH 7.01 to 7.15 OR base deficit 10 -15.9 mEq/L OR no blood gas available
AND
 1. History of an acute perinatal event
 2. 10 minute Apgar ≤ 5OR
Assisted ventilation initiated at birth and continuing for at least 10 minutes

Neurologic Criteria (either of two)

- Seizure (clinical seizures or documented by EEG)
- Moderate to severe encephalopathy identified by at least one finding in 3 of 6 separate categories (Stage 2 or Stage 3 Sarnat)

Note: Patients with mild encephalopathy (Stage 1 Sarnat) require close, repeated observation for progression to moderate or severe encephalopathy

SARNAT CATEGORY of ENCEPHALOPATHY	Mild Stage 1	Moderate Stage 2	Severe Stage 3
Level of consciousness	Hyperalert	Lethargic or obtunded <i>Lethargic:</i> delayed but complete response to stimuli <i>Obtunded:</i> delayed and incomplete response to stimuli	Stupor or coma <i>Stupor:</i> response only to strong or noxious stimuli, absent gag, shallow breathing or apnea <i>Coma:</i> no response
Spontaneous activity	Normal	Decreased activity	No activity
Posture	Mild distal flexion	Distal flexion w/complete extension (posturing of arms with flexion at wrists and extension at elbows), usually enhanced by stimulation	Decerebrate posturing (rigid posturing w/flexion at wrists, extension of arms and legs, toes pointing and opisthotonos)
Tone	Overactive	Hypotonic	Flaccid
Primitive reflexes: • Suck • Moro • Tonic neck	Weak Strong low threshold Slight	Weak Incomplete Strong	Absent Absent Absent
Autonomic system: • Heart rate • Respiration • Pupils	Tachycardia Regular Dilated, reactive	Bradycardia Periodic breathing Constricted, reactive	Variable heart rate Apnea Variable/unequal/fixe

Amplitude integrated EEG

AiEEG recordings may be used as an adjunct to physiologic and neurologic criteria, but should not be used alone as a screening tool in the selection of patients and should not replace physiologic or neurologic criteria.

Exclusion Criteria

- Gestational age < 35 weeks
- Severe congenital anomalies/syndromes/known metabolic disorder
- Severe IUGR (birthweight \leq 1800 grams)
- Infants in extremis for which no additional intensive therapy will be offered by attending neonatologist

Potential contraindications to cooling include:

- Coagulopathy with significant active bleeding, e.g., pulmonary hemorrhage (not just ETT blood alone), major GI bleeding, etc.

Discuss patients with these potential contraindications with an ECMO attending before deciding to cool (or not cool) an otherwise eligible patient

Infants with HIE who are excluded from active cooling should be followed closely to avoid hyperthermia. The patient's skin temperature should be kept at 36 ± 0.5 °C.

Caution Regarding Severe Pulmonary Hypertension: Cooling may exacerbate pulmonary hypertension. Patients with clinical or/and echocardiographic evidence of severe pulmonary hypertension may require both ECMO and cooling. These patients can receive body cooling through the ECMO circuit. Discuss all cooling candidates with pulmonary hypertension with an ECMO attending

Instructions for Referral Hospital

1. Contact attending neonatologist in the Children's Hospital Oakland NICU (510) 428-3431 for consultation regarding eligibility for cooling, any questions about passive cooling, or help with interpretation of a cerebral function monitor (CFM) recording. Arrange prompt transfer of patients meeting eligibility criteria by calling the Children's Hospital & Research Center Transfer Center at 855-CHO-KIDS (855-246-5437). The goal is to provide active cooling at a cooling center by 6 hours of life, but no later 8 hours of life, if passive cooling has been initiated at the referral hospital.
2. If the accepting neonatologist and referral physician determine that the patient meets treatment criteria, passive cooling should begin.
3. To begin passive cooling, turn table warmer off and monitor rectal temperatures every 15 minutes.
4. Check rectal temperatures by gently inserting a clean, lubricated digital thermometer into the rectum approximately ½ inch or 2 cm. Wipe thermometer with alcohol between uses.
5. The desired rectal temperature range is 33 - 34°C (91.4 - 93.2°F).

°C to °F conversion formula: $^{\circ}\text{C} = 5/9 \times (^{\circ}\text{F} - 32)$
6. Keep table warmer off unless rectal temperature $< 33.5^{\circ}\text{C}$ ($< 92.3^{\circ}\text{F}$)
7. If patient's rectal temperature falls below 33.5°C (92.3°F), turn table warmer on lowest setting or "preheat."
8. If patient's rectal temperature is greater than 34°C (93.2°F), continue passive cooling but do not attempt active cooling.
9. Maintain all other aspects of routine post-resuscitation care.
 - Maintain oxygenation and ventilation
 - Monitor blood pressure, heart rate, and perfusion
 - Obtain IV access
 - Provide IV fluids
 - Monitor glucose, electrolytes, CBC
 - Consider antibiotics
 - Treat clinical or electrographic seizures with a loading dose of 20 mg/kg Phenobarbital.
10. If the patient is hemodynamically unstable and/or has significant pulmonary hypertension, the baby may be too unstable to begin passive cooling. Whether or not such an infant should be started on cooling prior to or during transport should be discussed with the neonatologist at Children's Hospital Oakland.

Hyperthermia should be avoided in all patients with HIE, even if they are not eligible for passive or active cooling. In general, these patients should have a skin temperature of $36 \pm 0.5^{\circ}\text{C}$ ($97 \pm 1^{\circ}\text{F}$)

Instructions for Transport Team

Prior to Departure from CHRCO:

1. When the decision has been made to provide passive cooling on transport, adjust “set temp” of transport incubator to 30°C.
2. Prepare rectal probe by marking the length of insertion at 5 cm. Note that the rectal probe is kept in transport file box supplies.
3. Locate temp cable on transport monitor and connect rectal probe.
4. Turn transport monitor power [ON] so that temp reading appears on right lower screen.
5. Change alarm limits for temp as follows:
 - a. Press [set up] then [alarms] then [parameter]
 - b. Scroll down to [temperature] then [setting] then change limits
 - c. Press [down]. Set lower limit to [34°C] and high limit to [35°C].
 - d. Leave monitor power [ON]. Monitor defaults to previous setting when turned [OFF].

Upon Arrival at Referral Hospital:

1. Insert lubricated rectal temperature probe 5 cm into rectum and secure to patient’s leg using Tegaderm.
2. Record in the nursing notes the baseline rectal temperature off the transport incubator display panel.
3. Record rectal temperature and vital signs every 15 minutes.
4. If patient’s rectal temperature while in the transport incubator is > 34°C, open the incubator doors.
5. If patient’s rectal temperature in the transport incubator is < 33°C, increase incubator [set temp] to 32°C. A change in rectal temperature should appear within 6-10 minutes. If there is no change in rectal temperature after 10 minutes, increase incubator [set temp] to 33°C and continue monitoring. Keep the incubator [set temp] at 34°C and prepare for trip back to CHRCO.
6. If the patient is hemodynamically unstable and/or has an FIO₂ requirement of ≥50% to maintain adequate SPO₂, discuss with the Children’s Hospital Oakland attending neonatologist whether the baby is a candidate for passive cooling while on transport. Infants with significant hemodynamic instability and/or pulmonary hypertension are sometimes not candidates for passive cooling during transport. In this case, the patient’s temperature should be kept at 36 ± 0.5°C, and the transport incubator [set temp] should be at 36°C.

Upon arrival at CHRCO:

1. Keep rectal probe in place when transferring patient from the transport incubator to the table.
2. Connect rectal probe to Blanketrol® cable available at bedside.
3. Record the admission rectal temperature from the Blanketrol® machine.

Instructions for CHRCO NICU

Supplies:

- CFM machine with 3 needle electrode pack
- Blanketrol® machine with cooling blanket and temperature probes
- Sterile water 1000ml
- Ohmeda or Draeger radiant warming table
- Cooling protocols are available on CHONET (find on the duck)

Set up cooling blanket and begin active cooling:

- Refer to NEONATAL WHOLE BODY COOLING USING THE BLANKETROL III SYSTEM protocol.

CFM testing:

- Place CFM electrodes on patient and begin recording. Limit patient procedures including admission CXR and labs during this time if possible.
- If early CFM tracing is consistent with moderate-severe encephalopathy or seizures, continue cooling and CFM.
- If electrographic seizures are present, give phenobarbital and mark administration of medication on CFM tracing by:
 - Touch *MARKER*
 - Once in Marker mode, place a marker by touching the CFM trace area on screen
 - Select Standard or Custom tabs and type in information
 - Exit by touching Marker On.
- Print CFM tracing and tape copy onto progress note paper. Xerox copy and place into patient chart. In addition, write your interpretation of the recording below the tracing and sign.
- If the patient has received cooling, but DOES NOT MEET ELIGIBILITY CRITERIA based upon improvement of the neurological examination and the CFM data appears normal, begin gradual re-warming using the blanket and follow *Re-warming Procedure*. If patient meets eligibility criteria, continue cooling.

Labs, studies, and consultation:

- Send baseline labs as appropriate. Consider sending ABG with lactate, electrolytes, CBC, coags (PT, INR, PTT, fibrinogen), and LFTs. Correct all blood gases and pH values for core temperature.
- Order a conventional full channel EEG and neurology consultation within 24 hours of admission. Continuous EEG recording will be discontinued when the electrodes are routinely removed from the scalp at 48 hours. EEG monitoring, either aiEEG or full channel EEG, will be resumed during rewarming.
- Order a MRI (without sedation as clinically indicated) to be done on day 4-6 of life.
- A routine head ultrasound is unnecessary because the baby will receive a MRI. However, consider a head ultrasound for hemorrhagic brain injury or stroke if there is evidence of anemia, thrombocytopenia, consumptive coagulopathy, or focal abnormalities on the EEG.

During cooling:

- Begin a morphine infusion beginning at 0.01mg/kg/hr for shivering and discomfort.
- Changes in the baby's level of activity, including response to sedation, will change the amount of cooling needed.
- Minimize the amount of ultrasound/echo gel that is placed on the infant, because this will evaporate and increase cooling

Temperature recording:

- Nurse to record cooling start time and date on rand, nursing flowsheet and temperature flowsheet
- Nurse to record hourly vital signs, rectal temperature, water temperature, and gradient variable on temperature flowsheet

Continue cooling:

- The goal of cooling is to maintain the rectal temperature at **33-34°C** for the 72-hour cooling period.
- Cool the patient for 72 hours.

Rewarming procedure:

- Once the cooling period has ended, re-warm the infant gradually by 0.5° C increments every hour to reach a goal rectal temperature of 36.5° C.
- Provide continuous EEG monitoring because of the increased risk of recurrent seizures.
- If there is a high risk of increased seizures, the rewarming period may extend over 6 hours.