THAMES VALLEY & WESSEX NEONATAL OPERATIONAL DELIVERY NETWORK

THAMES VALLEY & WESSEX GUIDELINES FOR ASSESSMENT AND INITIATION OF THERAPEUTIC HYPOTHERMIA (COOLING) TREATMENT FOR BABIES PRESENTING WITH MODERATE OR SEVERE HYPOXIC ISCHAEMIC ENCEPHALOPATHY

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Authors	**Dr Eleri Adams, Consultant Neonatologist OUH** **Dr Frances O'Brien, Consultant Neonatologist OUH** **Dr Victoria Puddy, Thames Valley & Wessex Neonatal Network Clinical Lead** **Dr Michelle Fernandes, Neonatal Medicine GRID Registrar, Wessex Deanery; MRC Clinical Research Fellow, University of Southampton & Honorary Research Fellow, University of Oxford.** **Dr Magdalena Schreglmann Neonatal Neurology Fellow UHS**
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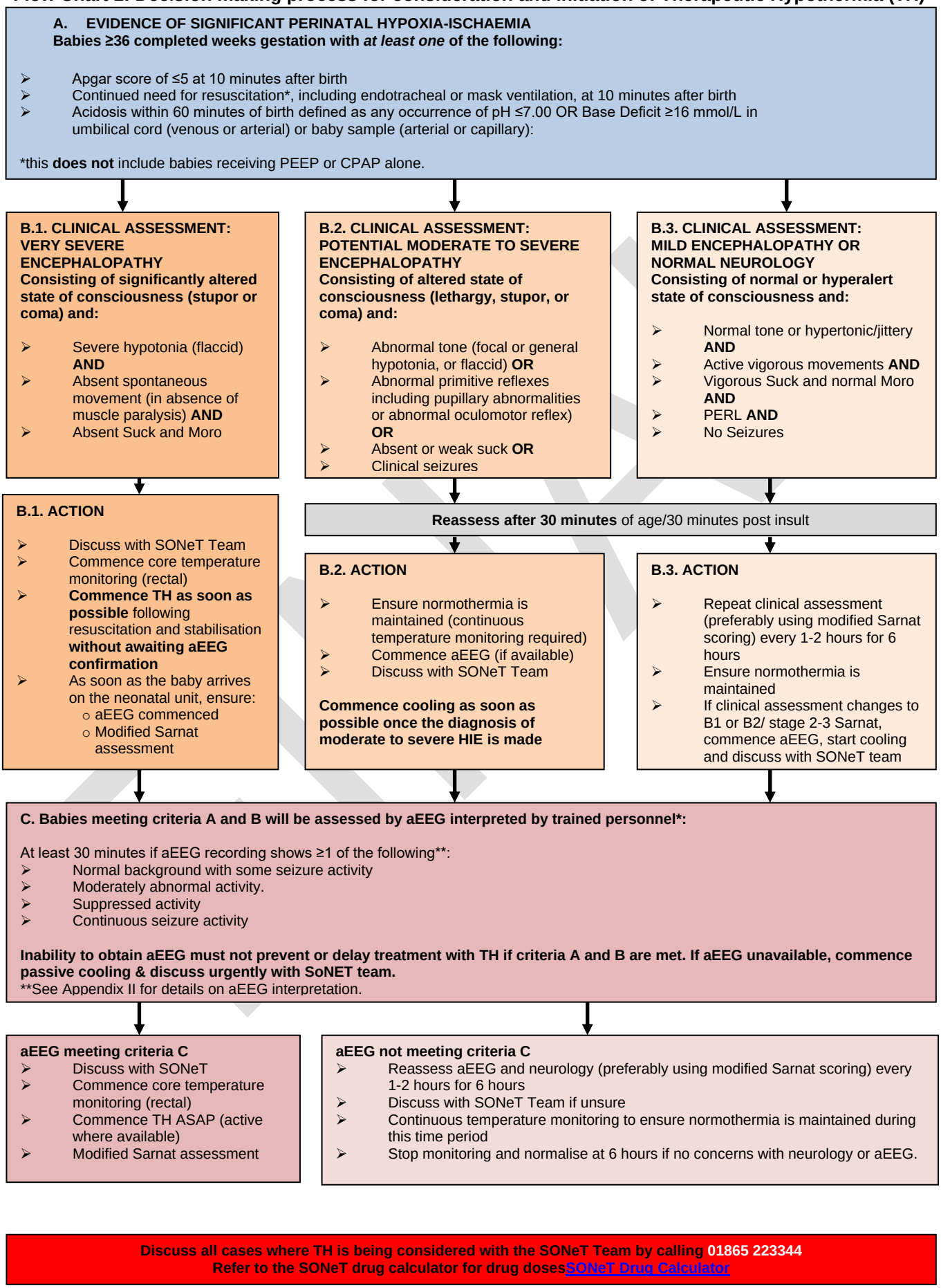
Implications of race, equality & other diversity duties for this document	**This guideline must be implemented fairly and without prejudice whether on the grounds of race, gender, sexual orientation or religion.**

SUMMARY:

Flow Chart 1: Decision making process for consideration and initiation of Therapeutic Hypothermia (TH)



DISCUSS ALL CASES URGENTLY WITH THE SONET TEAM: 01865 223344

How to Cool:
Initiation & management of babies undergoing TH in LNUs

1 → 2 → 3

ASSESSMENT

- Monitor temperature continuously
- Maintain **normothermia** during resuscitation & until decision to cool
- **Assess Criteria A, B & C** (if available)
- **Discuss with SONeT Team** (01865 223344)

INITIATION OF TH

- Obtain **rectal temperature**.
- **Initiate TH as early as possible**. Cool to **33-34 degrees** Celsius.
- Commence passive cooling if active cooling equipment unavailable
- **Do not delay cooling** if no CFM available, or vascular access not yet secured
- **Continuous monitoring** of temperature, HR, respiration, BP
- Complete **TV WNN Assessment for Therapeutic Hypothermia** (Appendix 1)
- Obtain parental **consent**

WHILST AWAITING ARRIVAL OF SONET TEAM

- **Ventilate:** avoid hypocapnia, use SIMV in preference to SIPPV. If paralysis required use boluses (not infusions)
- **Pain and sedation :** Consider non-pharmacological methods for pain management +/- morphine at 5-10 mcg/kg/hr
- **CVS:** Expect HR 80-100; if >110, consider inotrope or fluid requirements; consider inotropes if MBP<40 mm Hg
- **Monitor for hypoglycaemia and correct promptly**
- **Electrolytes:** Monitor and correct as necessary
- **Coagulopathy**: treat clinical oozing/haemorrhage with FFP, do not await lab studies
- Cover for **sepsis**, avoid aminoglycosides
- **Access**: Obtain **central access** if possible
- Consider **neuroprotection**: ear-muffs, monitor skin integrity
- Treat **seizures** as per local guidelines

DECISIONS REGARDING DRUGS & DOSING:

- ·If drugs are being considered, **discuss urgently with the SONeT team**
- ·Refer to the **SONeT drug calculator** for drug doses https://www.sort.nhs.uk/SONeT/Guidelines/Drug-calculators/Drug-calculators.aspx

1.0 Aim of Guideline

- To ensure that babies with suspected HIE are appropriately assessed to see whether therapeutic hypothermia (TH, cooling) is appropriate.
- To ensure that cooling is initiated in a safe and timely manner.
- To outline the care pathway for ongoing cooling treatment.

2.0 Scope of Guideline

The guideline applies to all neonates who fulfil the criteria for cooling set out in the guidance below, who are born in neonatal units and maternity units covered by Thames Valley & Wessex Neonatal Network. This includes the following hospitals:

Thames Valley		
TRUST	**Hospital**	**Designation**
Oxford University Hospitals NHS Foundation Trust	- John Radcliffe Hospital, Oxford	NICU
Buckinghamshire Healthcare NHS Trust	- Stoke Mandeville Hospital, Aylesbury	LNU
Frimley Health NHS Foundation Trust	- Wexham Park Hospital, Slough	LNU
Milton Keynes University Hospital NHS Foundation Trust	- Milton Keynes General Hospital	LNU
Royal Berkshire NHS Foundation Trust	- Reading	LNU

Wessex		
TRUST	**Hospital**	**Designation**
University Hospital Southampton NHS Foundation Trust	- Princess Anne Hospital	NICU
Portsmouth Hospitals University NHS Trust	- Queen Alexandra Hospital	NICU
Dorset County Hospital NHS Foundation Trust	- Dorset County Hospital, Dorchester	SCU
Hampshire Hospitals NHS Foundation Trust	- Basingstoke and North Hampshire Hospital	LNU
Hampshire Hospitals NHS Foundation Trust	- Royal Hampshire County Hospital, Winchester	LNU
Isle of Wight NHS Trust	- St Mary's Hospital	SCU
University Hospitals Dorset NHS Foundation Trust	- Poole Hospital	LNU
Salisbury NHS Foundation Trust	- Salisbury District Hospital	LNU
University Hospitals Sussex NHS Foundation Trust	- St Richard's Hospital, Chichester	SCU

3.0 Guideline

Introduction

- Neonatal encephalopathy has an incidence of approximately 1.5- 3/1000 births in the UK[1,2] .
- The incidence of moderate/ severe HIE requiring cooling in infants >34 weeks in Thames Valley & Wessex is currently (2018-2022) 1.3-1.7 per 1000 live births, and therefore 58-90 cases a year require cooling in the region.
- The risk of death or severe handicap in survivors of moderate or severe HIE is approximately 25 and 75% respectively[3], and children with and without motor impairments are at increased long-term risk of cognitive and behavioural problems as well as motor deficits[4].
- With the current practice of therapeutic hypothermia, mortality associated with severe HIE has decreased from 25% to 9% and disability from 20% to 16% in clinical trials, with a reduction in the rate of cerebral palsy[5,6,7].
- A Cochrane Review that included 11 trials on TH such as the UK total body cooling trial (TOBY) and US National Institute of Child Health and Human Development (NICHD) trial, confirmed that TH reduces death and disability at 18 months of age and improves neurodevelopmental outcomes in survivors with a number needed to treat of 7-11, depending on the outcome measured[8].
- Other meta-analyses have confirmed this finding and showed that the number needed to treat for survival with normal neurological function at 18 months is 7 (95% CI 5-11)[9] and 8 (95% CI 5-17)[10], respectively.
- Longer-term data at the age of 6-7 years by the TOBY and NICHD groups showed a benefit of TH for reduction of death and improvement of neurodevelopmental outcome up to school age[11,12].
- Clinically significant adverse events attributed to cooling are uncommon and the benefits of TH outweigh the possible short-term adverse effects[8].

- TH is now standard of care in selected neonates with moderate to severe HIE and is supported by NICE and BAPM[13, 14]. TH is not currently recommended in neonates with mild HIE.

Criteria and Assessment for Cooling:

- Cooling should be initiated as soon as possible once a diagnosis of moderate to severe HIE is made i.e. in all babies that meet criteria **A, B and C** (outlined in Flowchart 1). However, normothermia should be maintained during resuscitation and during the assessment period. ***Hyperthermia must be avoided*** as it increases the risk of brain injury.
- Criteria B should only take place after the baby has been stabilised and can be assessed and recorded shortly after delivery. However, the baby ***should be reassessed when the patient is more than 30 minutes old*** to allow time for spontaneous recovery post resuscitation. See https://learn.nes.nhs.scot/62008 for training resources on the neurological examination of infants with suspected HIE.
- Cooling therapy (either passive or active cooling) should not be commenced until the baby meets the clinical criteria for cooling outlined above **(criteria B assessment at >30 mins old** and criteria C when aEEG available). In the most severe cases, cooling can be commenced in the delivery suite prior to aEEG confirmation, provided rectal temperature monitoring is commenced. Babies undergoing aEEG assessment should have continuous temperature monitoring.
- ***Babies who meet these criteria but where cooling is NOT offered should have the reasons for this clearly documented in the notes so this decision can be justified, if necessary, in the future.***
- Babies who fulfil criteria A but not criteria B and C during the first hour should be reassessed 1-2 hourly until 6 hours of age (or after postnatal collapse), using either the criteria B assessment chart OR the Modified Sarnat Scoring on the TVWNN Assessment form, to ensure encephalopathy is not evolving.
- Where the baby has reached the threshold for aEEG review, reassessment of both aEEG and neurological assessment should continue for 6 hours. Where only criteria A is met, neurological assessment can cease once the neurological examination is normal beyond 2 hours post birth/ 2hrs following postnatal collapse. Babies can remain with mother for reassessments or be admitted to NNU at the discretion of the clinician.
- Where an infant meets criteria A but it is not possible to assess criteria B (e.g. paralyzing agents have been used prior to clinical neurological assessment), cooling should be commenced and Criteria C should be used to assess ongoing need for cooling. Initiation of cooling should not be delayed if Criteria C is not met because aEEG is not readily available.
- If pupils are unequal and/or cranial ultrasound suggests signs of intra-cranial tension or a large haemorrhage **do not cool even if criteria A, B and C are met**. Discuss with SONeT team for urgent transfer to neurosurgical centre.
- High risk babies born outside a hospital setting (e.g. at home, or standalone midwifery unit), should be kept normothermic until the patient is considered stabilised at the receiving hospital. Following this, a formal neurological assessment can be completed
- ***TVWNN*** Assessment for TH (*Appendix 1*) should be used to record assessments (use in all cases, even if CFM is unavailable).
- Where there is doubt regarding eligibility for ongoing cooling, advice should be sought from the SONeT team on 01865 223344.

Additional Assessments

Clinical Assessment

- Following the initial assessment, the severity of encephalopathy can be assessed using the Criteria B table on the THWNN assessment or alternatively using the modified Sarnat scoring system score[21, 22] (Table 1).
- A baseline modified Sarnat scoring system should be completed in all babies once a decision to cool has been reached.
- To complete the modified Sarnat score, assess all domains in the chart. Commence aEEG if any stage 2 or 3 criteria are met at any time. If unable to access aEEG, TH treatment should be initiated and advice sought from the SONeT team.

Stage 1 has a duration of less than 24 hours and consists of hyperalertness with a normal Moro, normal stretch reflexes, normal sympathetic effects and a normal EEG[21, 22]. Stage 2 infants are obtunded, hypotonic, with strong distal flexion, AND multifocal seizures[21, 22]. Stage 3 infants are stuporous, flaccid, with suppressed brain stem reflexes, depressed autonomic functions, and an isopotential EEG with periodic discharges[21, 22].

Presence of seizures indicates Stage 2 or 3. For an infant to be classified as Stage 2, ≥1 stage 2 criteria must be met. For an infant to be classified as Stage 3, ≥1 stage 3 criteria must be met[21, 22].

Table 1: Modified Sarnat Scoring System

Domain	Stage 1	Stage 2	Stage 3
Seizures	None	Common focal or multifocal seizures	Uncommon (excluding decerebration) or frequent seizures
Level of consciousness	Hyper alert/irritable	Lethargic/Obtunded	Stuperose/comatose
Spontaneous activity when awake or aroused	Normal	Decreased	Absent
Posture	Normal or mild distal flexion	Strong distal flexion, complete extension or frog-legged position	Decerebrate with or without stimulation (all extremities extended)
Tone	Normal – resists passive motion Hypertonic, jittery	Hypertonic or hypotonic/ floppy, either focal or general.	Completely flaccid like a rag doll
Primitive Reflexes	Suck: vigorously sucks finger or ET tube Moro – normal extension of limbs followed by flexion	Suck: weak Moro: incomplete	Suck: completely absent Moro: completely absent
Autonomic System	Pupils: normal size, reactive to light Heart rate: normal, >100 Respirations: normal	Pupils: constricted, <3 mm but react to light Heart rate: bradycardia, <100, variable up to 120 Respirations: periodic irregular breathing effort	Pupils: fixed dilated, skew gaze not reactive to light Heart rate: variable, inconsistent rate, irregular, may be bradycardic Respirations: completely apneic requiring positive pressure ventilation

Table 1 Modified Sarnat Score[21, 22]

Amplitude Integrated EEG (aEEG) Assessment

The aEEG (also known as Cerebral Function Monitor –CFM) is a single or dual channel time compressed and filtered EEG providing information on overall electrical activity in the brain. It provides information on the severity of encephalopathy and assessment of seizure activity (Appendix II) and is particularly helpful where an infant has been paralysed.

- The amplitude integrated EEG (aEEG or CFM) must be recorded in all babies treated with cooling ***but cooling must not be delayed or prevented if aEEG is not readily available or if there is clear clinical assessment of very severe HIE.***
- aEEG recordings should be recorded if the unit has access to this equipment; however,
- Follow manufacturer's instructions for application of EEG electrodes and machine setup. Further information on application and training in interpretation may be found at http://neoweb.org.uk.
- A normal aEEG record indicates a high probability of normal outcome, and clinicians may consider that treatment with cooling is not required.
- Rewarming following active cooling may be considered if the clinical examination is normal and the CFM normalizes within the first 6 hours. However, **ongoing neurological examination and CFM recording should occur during rewarming** and if any signs of deterioration occur the patient should be re-cooled for the full 72 hours. Early rewarming will generally not occur outside treatment centres.
- **Apparent improvement of the aEEG AFTER 6 hours of age is NOT an indication for discontinuing cooling.**
- A copy of the initial CFM traces should be sent with the baby to the cooling centre.
- IV anticonvulsant therapy may cause transient suppression of EEG activity. Ideally the aEEG should be performed before administering anticonvulsant therapy.

Cooling Outside Trial Guidelines

Evidence for cooling outside the above guidelines is weak or unavailable. However, there are circumstances where there may be theoretical benefits for cooling certain patients[15-17]. **TH in these circumstances should be considered but only be instigated following discussion with the local hospital consultant and cooling centre.**

Examples would include:

- Preterm babies between 34 – 36 weeks gestation who have suffered an acute hypoxic event and meet criteria A & B: Although some cooling centres offer TH to selected babies within this group, there are no randomized controlled trials to support this, only non controlled case series[16] and the risks of TH may be increased in late preterm babies[18]. In such cases, cooling should only be initiated after (i) a detailed discussion with parents explaining the associated risks and (ii) a second opinion from an experienced consultant, preferably from the cooling centre.
- Babies who fulfil criteria A+B but are between 6-24 hours old: there is modest evidence of benefit but the trial failed to complete and an interim analysis of the data did not reach conventional levels of statistical significant[19].
- Acute postnatal collapse with a neurological examination consistent with a diagnosis of acute encephalopathy: Although there are no randomized controlled trials providing evidence to support TH in this group, circumstantial evidence exists to support its benefit[16]. In such cases, cooling should only be initiated after (i) a detailed discussion with parents explaining the associated risks (ii) a second opinion from an experienced consultant, preferably from the cooling centre and (iii) an investigation of the underlying cause for the acute postnatal collapse.
- Mild neonatal encephalopthay: TH is not recommended in clinical practice in this group outside of clinical research trials.
- Early prolonged or recurrent seizures (within 12 hours of birth).

Prior to commencement of cooling treatment in these circumstances (outside trial guidelines) parents must be made aware that this treatment is not evidence-based and associated with risks.

Hypoxic ischaemia may co-exist or mimic other metabolic/neurological conditions and investigations to elucidate other causes of encephalopathy/seizures should be carried out where necessary.

Contraindications to Cooling

In all cases where there are concerns regarding contraindications to cooling should be discussed with SONeT.

Absolute contra-indications:

- Uncontrolled significant haemorrhage e.g. large pulmonary haemorrhage, large intra cranial haemorrhage, subgaleal haemorrhage
- Potential neurosurgical emergency e.g. unequal pupils, large intra cranial haemorrhage, evidence of intra-cranial space occupying lesion on cranial ultrasound.

Relative contra-indications include:

- Suspected thrombosis
- Oozing from umbilicus or mucus membrane (NB although hypothermia prolongs bleeding time, trials did not demonstrate differences in complications related to abnormal clotting; however if any bleeding manifestations give FFP (10 ml/kg over 30 minutes, and discuss with SONeT team) prior to commencing cooling and without awaiting clotting results).
- Surgical conditions likely to require early intervention.
- Severe PPHN - Cooling may produce adverse respiratory or cardiovascular effects. However, trials found no difference in the prevalence of PPHN between cooled patients and control groups.

Where Babies should be Treated with Cooling

- All units are expected to identify babies in need of cooling and initiate cooling treatment (either passive or active cooling)[14].

- Cooling is part of a range of intensive care treatments which babies with HIE may require and in accordance with BAPM[14] and Network guidelines[20], ongoing care should normally be delivered in a NICU.
- Babies should be transferred to the designated cooling centre (Oxford for Thames Valley; Southampton or Portsmouth for Wessex) for ongoing treatment by contacting the **SoNET team on 01865 223344**.

Initiation of Cooling Treatment Outside Cooling Centres

Pre-requisites to initiation of cooling:

- **Cooling should be started as soon as possible after fulfilling the assessment criteria and a rectal temperature probe inserted and a rectal temperature recorded**, as current evidence suggests that earlier cooling is more likely to be beneficial[15].
- ***Monitoring of rectal temperature is essential***. The rectal probe should be inserted 3-6 cm and secured to the thigh.
- Cooling treatment must not be delayed whilst IV access is attempted. Umbilical (central) access can be attempted with cooling initiated but cooling blanket will need to be kept open during the procedure and once access has been secured.
- Ensure pupils are equal in size. Unequal pupils are suggestive of a potential neurosurgical emergency which would require expedited transfer to neurosurgical centre – liaise urgent with SoNET team.

How to cool:

- Cooling to the desired temperature (33-34^{o}C) should occur as rapidly as possible.
- Cooling treatment whilst awaiting the arrival of the transport team should be active where possible
- Record the timing of commencement of cooling and the time the desired temperature (<34^{o}Cwas achieved on the TVNN Assessment form (*Appendix 1*).
- Continuous monitoring of HR, Respiration, BP, is advisable during cooling. Neonatal units using passive cooling should follow "Passive cooling – how to do it" in *Appendix III.*.
- Neonatal units using active cooling should follow manufacturers equipment instructions to cool babies to between 33-34^{o}C
- If a baby becomes overcooled (<33^{o}C) – rewarming to 33-34^{0}C should take place slowly – ideally no more quickly than-0.5^{o}C every hour.
- Complete TV WNN Assessment for Therapeutic Hypothermia (*Appendix 1*) and ensure copies are made for patient notes and for transfer.

Process of Referral for Ongoing Cooling Treatment

- The NICU attending consultant should be contacted via SONeT where clinical advice regarding suitability for cooling or ongoing management is required.
- For patients requiring ongoing cooling treatment, contact SONeT on 01865 223344 to arrange transfer to the nearest appropriate NICU
- **CONSENT** - Verbal parental assent should be sought for cooling treatment which requires transfer to the cooling centre and parents may be given a copy of the Bliss HIE - Information Leaflet for Parents (available free of charge at https://shop.bliss.org.uk/shop/files/HIE.pdf) or the local hospital information leaflet.
- Details of all discussion with parents about their infant's treatment with cooling should be documented in the infant's notes. Local Trust clinical governance procedures and policy for consent for treatment should be followed.

Management of Cooled Babies Whilst Awaiting Transfer

Ventilation

- Many babies treated with cooling will initially require mechanical ventilation as a consequence of their encephalopathy/anticonvulsant medication.
- Ventilatory care should be managed according to local protocols
- Hypocapnia must be avoided as it affected cerebral blow flow resulting in poor outcomes: where possible ETCO2 monitoring or transcutaneous CO2 monitoring must be commenced. Use SIMV in preference to SIPPV in cooled babies to reduce the risk of hypocapnia.
- Bolus doses of paralysis should be used, if required, rather than infusions to prevent drug accumulation.
- Blood gases will guide ventilatory requirements; particular care should be taken to ensure normocapnia. The infant's temperature should be inputted into the blood gas machine so that the appropriate adjustment is performed.
- Ventilator gases should be warmed and humidified in the normal way, according to local policy.

- More frequent suctioning may be necessary as secretions tend to be more viscous when cold. Vary positioning 6 hourly, Chest physio as indicated.

Cardiovascular support

- Most babies with a rectal temperature of 33-34ºC will have a heart rate around 80-100 bpm and a mean blood pressure greater than 40 mmHg.
- ***A heart rate consistently above 110 bpm in cooled babies suggests that the infant is distressed and/or* hypotensive/hypovolaemic. Consider *treatment with volume replacement and inotropes.***
- ***If the mean arterial blood pressure is less than 40 mmHg, consider treatment with volume replacement and inotropes.***
- ***If inotropes and other drugs are being considered in a baby undergoing TH, discuss urgently with SONeT team (T: 01865 223344) and refer to the SONeT drug calculator (https://www.sort.nhs.uk/SONeT/Guidelines/Drug-calculators/Drug-calculators.aspx) for drug doses.***
- Rise in heart rate may be due to distress, hypovolemia, hypotension, seizures or inotropes.

Managing Pain and Sedation

- Stress may have adverse effects in asphyxiated babies and may influence the therapeutic effect of hypothermia. Signs of distress include tachycardia, facial grimacing and irritability
- Consider non-pharmacological methods of comfort and pain management before commencing analgesic and sedative medications
- Consider sedation and analgesia with low dose intravenous morphine infusions commenced at 5-10 mcg/kg/hr (maximum dose 10 mcg/kg/hr in renal impairment) as per local unit guidelines, where pain and discomfort scores remain high despite non-pharmacological methods due to concerns that analgesic agents are themselves potentially neurotoxic.
- Review pain and sedation scores regularly and reduce morphine doses to prevent accumulation related toxicity as appropriate
- Respiratory function must be monitored in non-ventilated babies. There should be a low threshold for commencing ventilation, if required, in order to give adequate sedation/pain relief.

Fluid & Electrolyte Management

- Initial maintenance fluids at 40-60 ml/kg/day
- **Monitor for hypoglycaemia and correct promptly.** Maintain glucose ≥2.6mmol/L. Hypoglycaemia worsens brain injury by adding neurometabolic stress and must be avoided.
- Blood glucose should be monitored hourly in the first 2 hours, then 4- 6hourly or more frequently if hypoglycaemia occurs (follow local unit guidance). Where fluids are restricted, intravenous dextrose >10% may be required.
- Renal function is commonly impaired following severe perinatal asphyxia and fluids should be restricted according to local protocol in babies who have renal failure. It is advisable to avoid aminoglycosides.
- Watch for SIADH and avoid severe hyponatremia.
- Monitor electrolytes: calcium and magnesium may need replacement.

Vascular Access

- Cooling treatment must not be delayed whilst IV access is attempted.
- **Central access is preferred** as peripheral blood sampling is very difficult in babies with hypothermia. These babies often also require multiple infusions. Therefore, where possible, site a double lumen UVC and UAC.

Coagulation

- Send platelet count and clotting at the start of cooling.
- **If there are clinical signs of increased bleeding tendency (oozing/haemorrhage), treat babies with FFP (10 ml/kg over 30 minutes, and discuss urgently with SONeT team) without waiting for lab results.** Bleeding times did not increase during cooling in the TOBY trial but hypothermia can affect coagulation function.
- If significant bleeding occurs after commencement of cooling (eg. oozing from umbilicus) give FFP as soon as possible and consider rewarming by 0.5-1ºC or more if necessary.

Sepsis

- Antibiotic therapy may be given if clinically indicated. **Gentamicin and other aminoglycosides should be avoided** as there is a higher risk of toxicity**.**

Seizures

- The management of seizures should be guided by local protocols.
- In general, symptomatic seizures or frequent subclinical (>3/hr) seizures seen on aEEG/CFM should be treated with anticonvulsants.
- Cooling may affect the metabolism of several drugs, including anticonvulsants and sedatives, and toxic drug levels may occur even with normal doses.

Neuro-protection

- Babies undergoing TH are sensitive to auditory pathway injury; consider the use of ear muffs.
- Ensure the cooling jacket is not too tight so as to maintain skin integrity and prevent skin injury.
- Turn the infant regularly to reduce the risk of fat necrosis.
- Where staff are trained in the procedure and where it is safe to do so, facilitate a cool cuddle with the parents if the baby's clinical condition permits.

Neurodevelopmental Follow-Up

- All babies undergoing TH must undergo developmental follow-up post-discharge, due to increased risks of neurodevelopmental delays, at least until age 2 years[23,24].

Decisions about Drug Doses and Prescribing

- If drugs are being considered in a baby undergoing TH, please discuss this with the SONeT team (T: 01865 223344)
- Refer to the SONeT drug calculator for drug doses: https://www.sort.nhs.uk/SONeT/Guidelines/Drug-calculators/Drug-calculators.aspx

Version Control:

Version	Date	Details	Author(s)	Comments
1	July 2011	Final	EA	Board approved
2	Sept '15	Reviewed	EA/FO'B	1.1
1.2	Nov 2015	Reviewed TV& Wessex combined Guidance	EA/FO'B/VP,MS	1.3
3	Aug 2018	Reviewed	EA/FO'B	1.4
1.5	Sept 2018	Final	EA/FO'B	Board Approved
4	Oct 2022	Reviewed	MF/EA/VP	1.6
4.1	Nov 2022	Reviewed	MF/EA/VP	
4.2	Jan 2023	Reviewed	MF/EA/VP	Comments from JB, MC, CH, SS and LW provided and addressed
4.2	Jan 2023	Final	MF/EA/VP	
Review Date:	**January 2026**			

Appendices

Appendix I
TV&W NN: Assessment for TH
Authors: E Adams/M Fernandes/ V Puddy/ F O'Brien/ A Allen/N Crowley/R Evans.
Start Date: Jan 2023. Review: Jan 2026

Name: DOB: Address: (Or affix label)	**Reason for HIE Assessment (tick all that apply)**	Poor condition at birth	
		Seizures	
		Postnatal Collapse	
		Abnormal Neurological Examination	

Intrapartum history (tick all that apply)				**Post Delivery complications**	
Normal		Poor cord Gases		None	
Cord Prolapse		Shoulder Dystocia		Prolonged Resuscitation	
APH		Poor CTG		Poor Apgars	
Prolonged 2nd Stage		Fetal Distress		Poor Neonatal Blood Gases	
Thick Meconium		Uterine Rupture		Postnatal Collapse	

Further details:

Criteria A assessment

Apgar score ≤ 5 at 10 minutes		Baby needs to fulfil any ONE of Criteria A ie has evidence of perinatal hypoxia-ischaemia to be eligible for consideration of cooling.
Continued resuscitation including ventilation at 10 mins		
Acidosis ≤ 60 mins of birth (umbilical, art, cap pH < 7.0)		
Base deficit ≥ 16mmol/L ≤ 60 mins (umb, art, cap, ven)		

Criteria B assessment
Babies who fulfil criteria A but not criteria B during first hour should be reassessed 1-2 hourly until 6 hours of age (or after PN collapse) to ensure encephalopathy is not evolving. Reassessments can cease once the neurological examination is normal beyond 2 hours PNA/ 2hrs following postnatal collapse.

Date / Time		Post resusc.					
Age (minutes or hours post birth or post collapse)							
Cooling (No, passive or active)							
Temperature							
Seizures (clinical / electrical / both)							
Conscio-usness	Normal response to stimulation						
	Irritable						
	Poorly responsive						
	Comatose						
Tone	Normal						

	Increased						
	Decreased						
	Flaccid						
Primitive reflexes	Normal suck						
	Weak suck						
	Absent suck						
	Normal Moro						
	Exaggerated Moro						
	Partial / asymmetric Moro						
	Absent Moro						
Assessor name (initials)							

Some babies may appear neurologically abnormal immediately following resuscitation but will make a spontaneous recovery; therefore ***repeat the neurological assessment when patient is ≥30 mins old.*** Babies with ticks in unshaded boxes (except for post resuscitation assessment aged < 30 minutes) **do not** meet the full criteria for cooling unless they have seizures.

Where some boxes are shaded beyond 30 minutes, contact local consultant for assessment and the SONeT Team (T:01865 223344) for advice.

Meets Criteria A	Yes	No	Comment:
Meets criteria B	Yes	No	Comment:
Consultant advice	Yes	No	Advice:
Consultant name:			

Initial CFM assessment (Circle any / all that apply. CFM may not be available in all LNUs but is **not mandatory** prior to cooling)

CFM performed		Yes	No	Loss of sleep-wake cycle Electrical seizures present Burst suppression Isoelectric Status epilepticus Interference / artefact Difficult to interpret	CFM Comment
Lower margin	<5 uV	5-10 uV	>10 uV		
Upper margin	<5 uV	5-10 uV	>10 uV		
CFM Conclusion	**Normal / Mildly Abnormal / Moderately Abnormal / Severely Abnormal**				

Final decision regarding cooling	Requires Cooling		Comment:
	Does not require cooling		
Assessor name: Signature: Position:			Date: Time: Age:

TH details:

Passive cooling commenced	Date: Time: Age:	Active cooling commenced	Date: Time: Age:	Temperature <34ºC reached	Date: Time: Age:

Modified Sarnat Scoring System *(Please complete at commencement of cooling in ALL babies. Can also be used for ongoing assessment in first 6 hours instead of the chart above if preferred)*

Circle any / all that apply. Presence of seizures indicates Stage 2 or 3. For an infant to be classified as Stage 2, ≥1 stage 2 criteria must be met. For an infant to be classified as Stage 3, ≥1 stage 3 criteria must be met[19-20]. Commence aEEG if any stage 2 or 3 criteria are met.

Time of Assessment: _____

Assessor Name:
Signature:
Position:

Domain	Stage 1	Stage 2	Stage 3
Seizures	None	Common focal or multifocal seizures	Uncommon (excluding decerebration) or frequent seizures
Level of consciousness	Hyper alert/irritable	Lethargic/Obtunded	Stuperose/comatose
Spontaneous activity when awake or aroused	Normal	Decreased	Absent
Posture	Normal or mild distal flexion	Strong distal flexion, complete extension or frog-legged position	Decerebrate with or without stimulation (all extremities extended)
Tone	Normal – resists passive motion Hypertonic, jittery	Hypertonic or hypotonic/ floppy, either focal or general.	Completely flaccid like a rag doll
Primitive Reflexes	Suck: vigorously sucks finger or ET tube Moro – normal extension of limbs followed by flexion	Suck: weak Moro: incomplete	Suck: completely absent Moro: completely absent
Autonomic System	Pupils: normal size, reactive to light Heart rate: normal, >100 Respirations: normal	Pupils: constricted, <3 mm but react to light Heart rate: bradycardia, <100, variable up to 120 Respirations: periodic irregular breathing effort	Pupils: fixed dilated, skew gaze not reactive to light Heart rate: variable, inconsistent rate, irregular, may be bradycardic Respirations: completely apneic requiring positive pressure ventilation

Appendix II
TV&W NN: Interpretation of aEEG[25]
Authors: L Yianni/V Puddy/E Adama. Start Date: Dec 2021. Ratified: Dec 2021

The interpretation of the aEEG trace should be clearly documented in the medical notes, commenting on the upper and lower margins, background activity and waveform. The TV&W HIE assessment form provides a good structure for recording both the risk factors for HIE, the clinical examination and the aEEG results and interpretation. Use of this form is strongly encouraged (see TVW Guideline on Therapeutic Hypothermia).
Please note that where dual-hemisphere channels are available, the overall aEEG trace should be used for determining background activity (NOT the individual hemisphere traces).
There are **3 parameters** that can be measured by a Cerebral Function Monitor (CFM), all of which should be taken into consideration when interpreting and reporting. They are as follows:

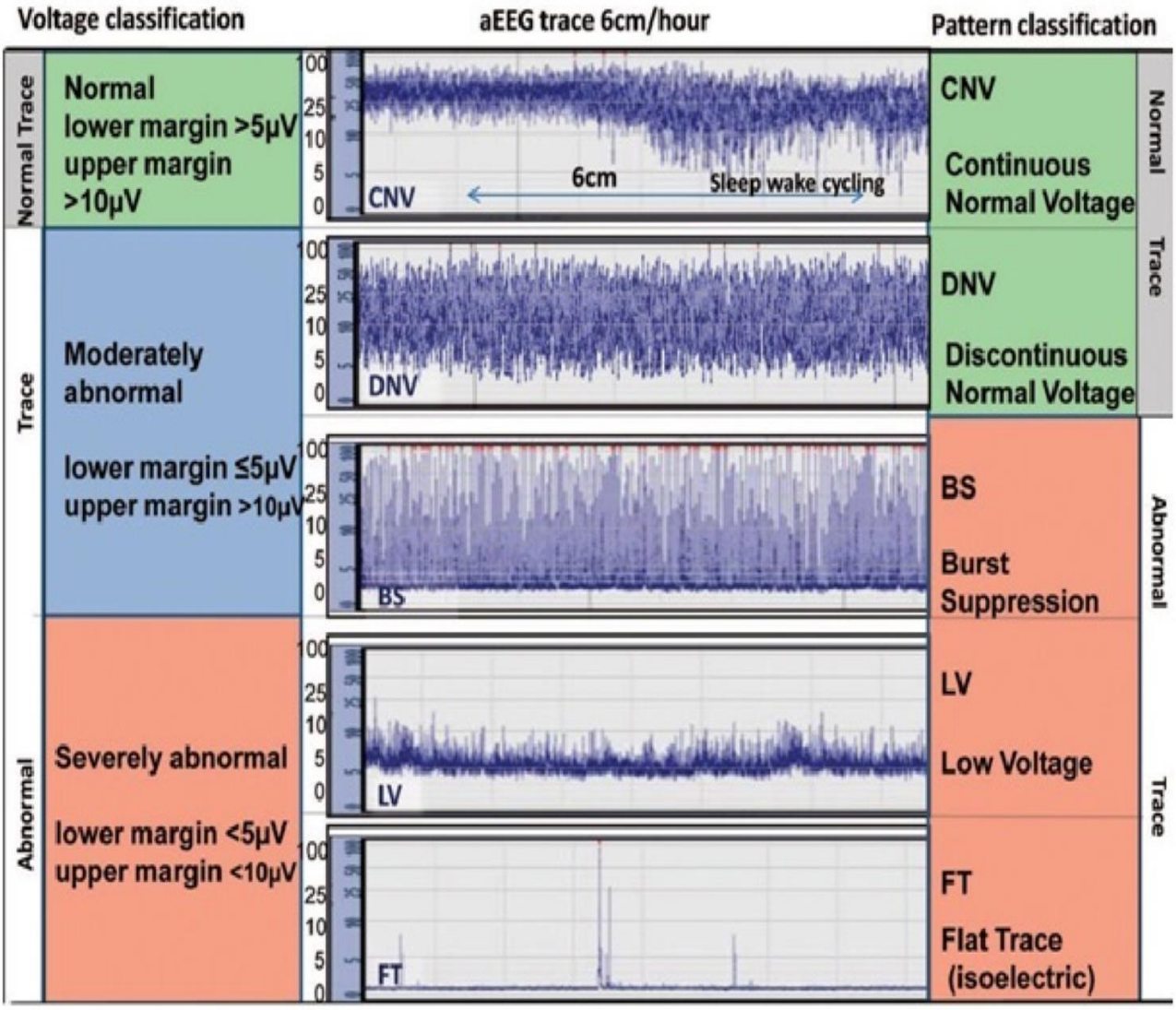
Impedance	• A measure of the electrical signal's conductivity • Measured in Ohms (Ω) • Tells you how good the contact is between electrodes and the scalp • Loss of contact can increase artefact in the aEEG • <5 Ω is very good • 5-10 Ω is acceptable • If > 10 Ω check the electrodes placement • When reporting the aEEG, document the impedance as part of this
Raw-EEG	• This is the raw electrical signal measured directly from the electrodes before it is rectified and compressed by the monitor into the aEEG trace • Inspect this when reporting to differentiate between seizures and artefact and to differentiate between the different background patterns
Amplitude-integrated EEG (aEEG)	• This is the rectified and compressed trace the monitor makes from the raw EEG. • The EEG is compressed to 1hr/6cm • It gives information on cerebral function, the characteristics should be documented

CLASSIFICATIONS OF aEEGs

There are two approaches to interpreting the aEEG trace in CFM monitoring:

1. Using **voltage classification** to identify the severity of the aEEG background (1)
2. Using **pattern classification** to describe the aEEG background activity (2)

Please see the diagram below that describes both voltage and pattern classifications (3). Please see appendix 3 of the CFM guideline[23] for CFM trace examples.



A simple semiquantitative classification is used in the Toby study (4):

1. **Normal**: The upper margin of the trace is above 10 microvolts and the lower margin is greater than 5 microvolts. In healthy, full term babies the trace alters in width according to the state of the infant. The trace is narrower when the infant is awake and widens during sleep. These changes in width of the trace with infant state are called sleep/wake cycling. In normal babies the width of the trace varies from approximately 10-40 microvolts.
2. **Moderately abnormal**: The upper margin of the trace is greater than 10 microvolts and the lower margin is less than 5 microvolts. This appearance can be seen in babies with moderately severe encephalopathy, or immediately after administration of drugs such as anticonvulsants and sedatives. This pattern may also be seen in preterm babies (below 36 weeks gestation).
3. **Severely abnormal:** The upper margin of the trace is less than 10 microvolts. The lower margin is usually less than 5 microvolts but on occasion the lower margin may be raised above 5 microvolts because of interference from ECG or other artefacts. A severely abnormal trace is characterised by a general suppression of amplitude so that the trace appears narrow and of low voltage. This pattern may be accompanied by brief bursts of higher voltage spikes, which appear as single spikes above the background activity. This appearance is sometimes called “burst suppression”. A severely abnormal trace is usually seen with severe encephalopathy and is often accompanied by seizure activity.

Further pattern descriptions also include:

- Mildly abnormal trace
- Sleep wake cycling
- Seizures
- Artefacts

Mildly abnormal trace:

The upper and lower margins are normal but there is lack of sleep wave cycling. This is commonly seen in babies with mild HIE who may be hyperalert and hypertonic. It is also commonly seen after administration of sedative medication. This trace is not an indication for cooling treatment.

Sleep wake cycling (SWC):

Normal finding characterized by smooth sinusoidal variations, mostly in the lower amplitude. Broader bandwidth represents discontinuous background activity during quiet sleep, and narrower bandwidth corresponds to the more continuous activity during wakefulness and active sleep. Loss of sleep wake cycling occurs in mild HIE and is also seen in response to some sedative and anticonvulsive medication.

Seizures:

Seizure activity in aEEG is seen as an abrupt rise in the lower and upper amplitude and narrowing of the bandwidth. The raw EEG may confirm seizures by the presence of repetitive rhythmical spike and wave discharges.

References:

1. Niran al Naqeeb, A. David Edwards, Frances M. Cowan, Denis Azzopardi Assessment of Neonatal Encephalopathy by Amplitude-integrated Electroencephalography Pediatrics Jun 1999, 103 (6) 1263-1271
2. Hellström-Westas, L. et al. “Amplitude-integrated EEG Classification and Interpretation in Preterm and Term Babies.” *Neoreviews* 7 (2006): 76-87
3. Kostałkowski, M. K.. “aEEG analog front end IC for a neonatal brain development monitoring.” (2016).
4. Azzopardi D, 2008. Olympic CFM examples 08. [online] Available at: http://www.neoweb.org.uk/CFM/CFM_Examples.htm

Appendix III