HYPOXIC ISCHAEMIC ENCEPHALOPATHY MANAGEMENT FORM

Supportive Management

Ventilation	Support breathing when necessary		
	Avoid hypocarbia (decreases cerebral blood flow) ➔ keep $PaCO_2$ 40-55mmHg		
	Avoid hyperoxia ➔ keep PaO_2 50-100mmHg		
	Monitor for PPHN (see protocol)		
Circulation	Maintain mean BP 40-60mmHg to maintain adequate cerebral perfusion		
	If clinical PPHN ➔ start appropriate management (see protocol) and request cardiac sonar		
	Manage hypotension	If hypotensive ➔ do cardiac sonar to determine RV and LV function	
		Hypovolaemic ➔ fluid bolus (only if normal cardiac fx) ➔ start with 10ml/kg, followed by an inotrope if necessary (dopamine is 1st-line)	
		Normovolemic ➔ dopamine is 1st-line, dobutamine 2nd-line	
		Myocardial dysfx ➔ avoid fluid bolus ➔dobutamine is 1st-line, dopamine 2nd-line	
		3rd-line management ➔ consider hydrocortisone (sepsis), or adrenaline infusion (sepsis and myocardial dysfx)	
Fluid & Nutrition	Start fluid volume at 60ml/kg/day (including enteral feeds)		
	Decrease total volume if poor urine output (<1ml/kg/hr). Only increase daily fluid volume if urine output adequate (≥1ml/kg/hr)		
	Start trophic feeds (20ml/kg/d) on day of birth and continue low volume until after re-warming (72 hours)		
	Give enteral feeds via NGT until sucking and swallowing assessed		
	TPN must be prescribed until on full enteral feeds		
Renal	Aminophylline (dose: 8mg/kg ivi stat) within 1st hour of birth to prevent AKI		
	Place urine catheter to monitor fluid balance		
	If positive fluid balance and urine output <1ml/kg/h	Suspect intrinsic renal	Diuretic trial (lasix 1mg/kg ivi stat)
		Suspect pre-renal (hypovolemia)	Fluid bolus (10ml/kg saline)
		No response to above measures	Restict fluid to urine output plus insensible losses (20-25ml/kg/d)
	If oliguric / anuric ➔ avoid potassium-containing fluid		
	If hyperkalemic (K^+ > 7mmol/L) ➔ treat (see protocol)		
	Monitor for SIADH (decreased UO, serum Na < 130mmol/L, urine SG >1020 (increased osmolarity)		
Cerebral	Clinical examination documenting modified sarnat and Thompson score		
	Attach aEEG ➔ intepret voltage and background patterns (see next page)		
	Monitor for seizures (see protocol to diagnose & treat seizures)		
	Routine phenobarbitone prophylaxis to prevent seizures is NOT recommended		
	NB: seizures soon after delivery (1 to 6 hours of life) and those starting after 24 hours of life are NOT consistent with an acute intrapartum event		
	Exclude meningitis in ALL patients		
	There is NO evidence for steroid use to prevent / treat cerebral oedema in patients with HIE		
Metabolic	Monitor hgt ➔ prevent hypoglycemia		
	Monitor electrolytes		
	Cord arterial gas or infant arterial blood gas within 1 hour of birth		
	Do NOT use $NaHCO_3$ infusion to correct metabolic acidosis		
Temperature & cooling	Avoid hyperthermia		
	Determine eligibility for cooling (see next page)		
	If eligible, start as soon as stabilised (improved neurological outcome when cooling started within 3 hours of birth)		
	Core temperature target: 33.5-34.5°C for 72 hours		
	Use whole body cooling method (criticool), but if not available use gel pack method if sufficient staffing available		
	Provide sedation if agitated / shivering while receiving cooling (valeron drops)		
	Once completed 72 hours of cooling ➔ Rewarm at 0.5 °C per hour		

REFERENCES: Martin RJ, Fanariff AA, Walsh MC. Neonatal-Perinatal Medicine-Diseases of the fetus and infant. 9th ed. Vol 2, Ch 40 (pg 952-976 / Raina A, et al. Treating perinatal asphyxia with theophylline at birth helps to reduce the severity of renal dysfunction in term neonates. Acta Paediatrica 2016;105:e448-51 / Wu et al. Clinical features, diagnosis and treatment of neonatal encephalopathy. UpToDate2017 / Martinello et al. Management and investigation of neonatal encephalopathy: 2017 update. Arch Dis Child Fetal Neonatal Ed 2017 / Douglas-Escobar, et al. Hypoxic-ischemic encephalopathy: A review for the clinician. JAMA Pediatrics 2015;169(4):397-403 / Selewski, et al. Neonatal acute kidney injury. Pediatrics 2015;136(2):e463-473 / Risk management in obstetrics and neonatal-perinatal medicine, ch 15, pg 272-78 / Young L, et al. Prophylactic barbiturate use for the prevention of morbidity and mortality following perinatal asphyxia (Review). Cochrane 2016 / Jacobs et al. Whole-body hypothermia for term and near-term newborns with hypoxic-ischemic encephalopathy. Arch Pediatr Adolesc Med 2011;165(8):692-700

ELIGIBILITY CRITERIA FOR THERAPEUTIC HYPOTHERMIA				YES	NO
CRITERIA (A), (B) AND (C) MUST BE PRESENT					
Age and gestation (A)		**AND**	≥ 36 weeks gestational age		
			≤ 6 hours of life		
AND					
Evidence of intrapartum asphyxia / hypoxia (B)			pH ≤ 7 OR BE ≥ -16 *(Arterial cord blood or neonate arterial specimen within 60 minutes of birth)*		
		OR	5 and 10 minute Apgar ≤ 5		
		OR	Ongoing resuscitation from birth to 10 minutes		
AND					
Evidence of Encephalopathy ©	**Clinical Examination (defined by the presence of one or more signs in at least 3 of the 6 categories of the Modified Sarnat Score#**		Moderate or severe encephalopathy (Please circle the criteria defining encephalopathy in the table below) **OR** clinical seizures		
	Abnormal aEEG	Seizures	Abrupt rise in both upper and lower margins		
		Abnormal background or voltage	Discontinuous (Moderately abnormal): Upper band >10, Lower band <5		
			Continuous low voltage (Suppressed): Upper band <10, Lower band <5		
			Isoelectric / flat (Suppressed): Upper band <5, Lower band <5		
			Burst suppression		

REFERENCES: Olsen et al. Optimizing therapeutic hypothermia for neonatal encephalopathy. Pediatrics 2013;131(2):e1-15 / Shankaran, et al. Whole-body hypothermia for neonates with Hypoxic-ischaemic encephalopathy. NEJM 2005;353:1574-84 / Gluckman, et al. Selective head cooling with mild systemic hypothermia after neonatal encephalopathy: multicenter randomized trail. Lancet 2005;365(9460):663-670 / Azzopardi DV, et al. Moderate hypothermia to treat perinatal asphyxial encephalopathy. NEJM 2009;361(14):1349-1358 / Simbruner G and neo.nEURO.network Trial Participants. Systemic hypothermia after neonatal encephalopathy: Outcomes of neo.nEURO.network RCT. Pediatrics 2010;126(4):e771-e778 / al Naqeeb, et al. Assessment of neonatal encephalopathy by amplitude-integrated electroencephalography. Pediatrics 1999;103(6):1263-1271 / Hellstrom-Weatas, et al. Amplitude-integrated EEG classification and interpretation in preterm and term infants. Neoreviews 2006;7:e369-374

Modified Sarnat Staging#			
	Category	**Moderate encephalopathy**	**Severe encephalopathy**
1	**Level of consciousness**	Lethargic	Stupor or coma
2	**Spontaneous activity**	Decreased activity	No activity
3	**Posture**	Distal flexion, complete extension	Decerebrate
4	**Tone**	Hypotonia (focal or general)	Flaccid
5	**Primitive reflexes**		
	Suck	Weak	Absent
	Moro	Incomplete	Absent
6	**Autonomic system**		
	Pupils	Constricted	Deviated, dilated, or non-reactive to light
	Heart rate	Bradycardia	Variable
	Respiration	Periodic breathing	Apnoea

REFERENCES: #Shankaran, et al. Whole-body hypothermia for neonates with Hypoxic-ischaemic encephalopathy. NEJM 2005;353:1574-84 / Shankaran. Neonatal encephalopathy: Treatment with hypothermia. NeoReviews 2010;11(2):e85-92

Special investigations

		D 1	D 2	D 7-10	NOTES:
Exclude other pathology	**Request placental pathology**	X			Document appearance and weight. Identify adverse growth events and/or infections as alternate etiologies of NE
	Blood culture	X			
	Lumbar puncture	X			
	Crainial Sonar	X	X		Markers of cerebral oedama: sparkly echo reflectance of parenchyma, obscured sulcal markings, and closure of fissures. Appears approximately 24 hours after a hypoxic event and resolves in 3-5 days. Slit-like ventricles are a NORMAL sonographic finding in term infants
Evidence of Multi-organ involvement (Record all results in separate flow sheet)	**FBC, diff, platelets**	X	X		Maintain plts > 50 $x10^9$/L
	Urine dipsitx		X		Document hematuria
	UKE		X		AKI: Serum creatinine rises > 27umol/L within 48hours, OR rise ≥ 1.5x baseline, OR ≥ 221umol/L (Modified KDIGO classification)
	INR / PTT		X		Transfuse FFP if INR > 2
	AST / ALT		X		
	CMP		X		Correct hypocalcemia and hypomagnesemia
	Troponin T		X		≥100 ng/L indicates myocardial injury. If present, request cardiac sonar
	MRI brain			X	Two characteristic patterns of injury: 1) BG, thalami, and peri-rolandic cortex; 2) parasaggital watershed distribution
	aEEG	X			See previous page for description of aEEG background patterns
	EEG		X		Repeat if abnormal
Evoked potentials	**Hearing screening (ABR)**	Book as outpatient			
	Vision screening (VEP)	Book as outpatient			

<u>REFERENCES:</u> Martin RJ, Fanariff AA, Walsh MC. Neonatal-Perinatal Medicine-Diseases of the fetus and infant. 9th ed. Vol 2 / Szymankiewicz, et al. Usefulness of cardiac troponin T and echocardiography in the diagnosis of hypoxic myocardial injury of fullterm neonates. Biol Neonate 2005;88:19 / Risk management in obstetrics and neonatal-perinatal medicine, ch 15, pg 272-78 / Martinello et al. Management and investigation of neonatal encephalopathy: 2017 update. Arch Dis Child Fetal Neonatal Ed 2017 / Selewski, et al. Neonatal acute kidney injury. Pediatrics 2015;136(2):e463-473 / Martinello et al. Management and investigation of neonatal encephalopathy: 2017 update. Arch Dis Child Fetal Neonatal Ed 2017

PROGNOSTICATION (LONG-TERM)

Score	1	2	3
Limb tone	Generally hypertonic	Genaerally hypotonic	Flaccid
LOC	Hyperalert, hyper-reactive or staring	Lethargic / Obtunded	Comatose / Stuporose
Visible fits	Infrequent (< 3/day)	Frequent (>2/day)	
Posture	Fisting and/or cycling	Strong distal flexion	Decerebrate
Moro	Partial	Absent	
Grasp	Poor	Absent	
Suck	Poor	Absent and/or bites	
Resp effort	Hyperventilation	Brief apnoea	Apnoea (IPPV)
Fontanelle	Full, not tense	Tense	

Thompson CM, et al. The value of a scoring system for hypoxic ischaemic encephalopathy in predicting neurodevelopmental outcome. Acta Paediatr 1997;86:757-761

Day	1	2	3	4	5	6	7	8	9	10
Date										
Time										
Tone										
LOC										
Fits										
Posture										
Moro										
Grasp										
Suck										
Resp										
Font										
Total										

Intepretation of Thompson score	PPV (%) (Abnormal outcome)	NPV (%) (Normal outcome)	Sensitivity (%)	Specificity (%)
Seizures	57	92	94	48
Subcortical leukomalacia	100	74	53	100
Max score >10	65	100	100	61
Score D3 >10	73	94	94	74
Score D4 >10	75	90	88	78
Max score >15	92	82	71	96
Score D3 >15	89	71	47	96
Score D4 >15	90	73	53	96
AbN score D7	63	100	100	57

NOTE: These predictors were determined in the pre-cooling era