Local Guideline

Neonatal Encephalopathy management in NICU

Sites where Local Guideline applies	Neonatal Intensive care Unit, JHCH
This Local Guideline applies to:	
1. Adults	No
2. Children up to 16 years	No
3. Neonates – less than 29 days	Yes
Target audience	NICU clinical staff who provide care to neonatal patients with Neonatal Encephalopathy
Description	Guideline for the description of neonatal encephalopathy and treatment

Hyperlink to Guideline

Keywords	Asphyxia, Cooling, Electroencephalogram (EEG), Hypoxic Ischaemic Encephalopathy (HIE), Sarnet, Seizures
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Related Legislation, Australian Standard, NSW Ministry of Health Policy Directive or Guideline, National Safety and Quality Health Service Standard (NSQHSS) and/or other, HNE Health Document, Professional Guideline, Code of Practice or Ethics:

- NSW Health Policy Directive 2014_036 Clinical Procedure Safety http://www0.health.nsw.gov.au/policies/pd/2014/pdf/PD2014_036.pdf
- NSW Health Policy Directive 2010_006 Whole Body Cooling - Neonates Suspected Moderate or Severe Hypoxic Ischaemic Encephalopathy(HIE) http://www0.health.nsw.gov.au/policies/pd/2010/PD2010_006.html

Prerequisites (if required)	Nil
Local Guideline note	This document reflects what is currently regarded as safe and appropriate practice. The guideline section does not replace the need for the application of clinical judgment in respect to each individual patient but the procedure/s **require mandatory compliance**. If staff believe that the procedure/s should not apply in a particular clinical situation they must seek advice from their unit manager/delegate and document the variance in the patients health record.
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RISK STATEMENT

This local guideline has been developed to provide guidance to clinical staff in NICU to assist in assessment and management of neonatal encephalopathy. It ensures that the risks of harm to the infants whilst caring for an infant with neonatal encephalopathy are identified and managed. *Any unplanned event resulting in, or with the potential for injury, damage or other loss to infants/staff/family as a result of this management must be reported through the Incident Information management System and managed in accordance with the Ministry of Health Policy Directive: Incident management PD2007_061. This would include unintended injury that results in disability, death or prolonged hospital stay.*
Risk Category*:* *Clinical Care & Patient Safety*

GLOSSARY

Acronym or Term	**Definition**
AKI	Acute kidney injury
Asphyxia	The state in which placental or pulmonary gas exchange is compromised or ceases altogether
CTG	Choriotocograph
DIC	Disseminated Intravascular Coagulopathy
DWI	Diffusion-weighted imaging
ECG	Electrocardiograph
EEG/aEEG	Electroencephalogram/amplitude EEG
FHR	Foetal heart Rate
Hb	Hemoglobin
HIE	Hypoxic Ischaemic Encephalopathy
Hypoxia or Anoxia	A partial (hypoxia) or complete (anoxia) lack of oxygen in the brain or blood
Hypoxic-Ischemic Encephalopathy	Abnormal neurologic behavior in the neonatal period arising as a result of a hypoxic-ischemic event
iNO	Inhaled nitric oxide
Ischemia	The reduction or cessation of bloodflow to an organ which compromises both oxygen and substrate delivery to the tissue
NE	Neonatal encephalopathy
NEC	Necrotising Enterocolitis

Neonatal encephalopathy	Abnormal neurological behaviour in the neonatal period
OBM® & BRM3 monitor	Olympic Brainz™ Monitor /Brainz™ Monitor No 3 version
Perinatal asphyxia	a condition in the neonate where there is the combination of an event or condition during the perinatal period that is likely to severely reduce oxygen delivery and lead to acidosis AND compromised function of at least two organs consistent with the effects of acute asphyxia
PCR	polymerase chain reaction-molecular biology techniques
PLIC	posterior limb of the internal capsule

Neonatal Encephalopathy management in NICU - One Page Summary and Checklist

(Ctrl+Click on **Coloured** words to jump to that section)

Top

GUIDELINE

This Guideline does not replace the need for the application of clinical judgment in respect to each individual patient.

Neonatal encephalopathy

Background

Top

Neonatal Encephalopathy (NE) is a clinically defined syndrome of disturbed neurological function in the earliest days of life in the newborn infant, manifested by difficulty with initiating and maintaining respiration, alteration of tone and reflexes, altered level of consciousness and often seizures.

NE occurs in approximately 3.5 - 6/1000 live births and usually recognised in the full term infant. The terminology NE as a working diagnosis is preferred to Hypoxic Ischemic Encephalopathy (HIE) as it is not always possible to document a significant hypoxic-ischemic insult and there are several other (non-hypoxic-ischemia) causes of NE.

The most common cause of NE remains a perinatal hypoxic event leading to hypoxic ischaemic encephalopathy (HIE), with neonatal stroke as the second most likely cause. Other causes of NE include nervous system malformations and degenerative syndromes, metabolic disease, infection, intracranial bleed, and drug withdrawal. The requirement for investigation to exclude these possibilities will depend on the presentation, history and clinical features of the individual case.

This guideline will try to discuss neonatal encephalopathy in general, but focus will often shift to HIE as this is the most common cause of NE, and most data on diagnosis and treatment are determined for this specific group.

Risk factors for the development of neonatal encephalopathy

Top

The incidence of antenatal and intrapartum asphyxia that can lead to NE is higher in complicated pregnancies, particularly those associated with diminished placental reserve including:

- hypertensive disease of pregnancy or pre-eclampsia,
- intrauterine growth restriction,
- placental abruption,
- foetal anaemia (e.g. rhesus incompatibility or feto-maternal haemorrhage),
- post maturity,
- non-physiological labour (e.g. induction or instrumental delivery)
- malpresentation including vasa praevia.

Only about half of the infants needing resuscitation are predicted by antenatal history or signs during labour.

The following predictors have been assessed for their ability to predict low Apgar scores:

- Foetal movement counting,
- non-stress testing,
- foetal biophysical profile,
- abnormal foetal heart rate (FHR) recording,
- Foetal scalp pH.

Reduced liquor volume and meconium staining of the liquor are associated with a low Apgar score.

Diagnosis of neonatal encephalopathy

Top

NE is a clinical diagnosis based on neurological examination and brain activity on EEG (Electro-encephalograph) or aEEG (amplitude EEG monitoring at the bedside). However, NE does not describe what caused this altered neurological state, and further details on pregnancy, birth and postnatal signs and symptoms and investigations are needed for the final diagnosis with a causal pathway.

The assessment should include a history of maternal and intra-partum risk factors for problems that may affect the infant including pre-existing medical conditions in the mother, problems of pregnancy, abnormalities identified antenatal in the foetus, the presence of meconium stained liquor, CTG abnormalities, scalp pH, maternal indicators of infection, presentation and method of delivery.

Documentation of the resuscitation should include the Apgar score, arterial and venous cord blood gases, time to sustained spontaneous respiration, and neurological status at admission.

During admission, frequent (every 8 hours for first 24 hours and then daily) documentation of the neurological status with grading of encephalopathy by clinical examination (modified Sarnat staging, see below) and daily evaluation of multi-organ function should take place until normal function is restored.

Diagnosis of neurological status and multi-organ function

Neurological status

Neurological examination (modified Sarnat staging) including level of consciousness, activity, neuromuscular control, complex and primitive reflexes, autonomic function and the presence of seizures should be documented. Three clinical stages of encephalopathy are described:

Mild encephalopathy (Sarnat stage 1) lasts less than 24 hours with hyper alertness, irritability, over sensitive to stimulation, uninhibited Moro and stretch reflexes, sympathetic over-stimulation with tachycardia, dilated pupils and jitteriness, and with a normal electroencephalogram. These infants often have mild feeding problems and no need for mechanical ventilation beyond the resuscitation period.

Moderate encephalopathy (Sarnat stage 2) shows more lethargy (difficult to rouse), decreased spontaneous movements and muscle tone varying between hypertonia with strong distal flexion or hypotonia and proximal weakness. There is parasympathetic overstimulation with low resting heart rate, small pupils, and copious secretions. There are often moderate feeding problems and mechanical ventilation can be required to support respiration. The EEG is abnormal, with burst-suppression pattern or depression and over half the infants will have seizures.

Severe encephalopathy (Sarnat stage 3) is the extreme end of encephalopathy. The newborn is in coma (cannot be roused), flaccid tone, with absent reflexes and suppressed brain stem and autonomic functions. The EEG is severely depressed or has infrequent periodic discharges.

A modified Sarnat staging system in presented in the table below. Assign the Sarnat stage that best describes the patient at the time of examination. If unsure, describe staging per item separately.

Modified Sarnat staging			
Stage	1	2	3
Level of consciousness	Hyper alert	lethargic (reduced response to non-painful stimuli)	stupor or coma (minimal or no response to painful stimuli)
Spontaneous activity	Normal or irritable	decreased	absent
Neuromuscular control			
Muscle tone	Normal or increased tone	mild hypotonia (reduced trunk and/or extremity tone)	Flaccid (minimal or no tone)
Posture	mild distal flexion	strong distal flexion	intermittent decerebration (extension)
Stretch reflexes	overactive	overactive	decreased or absent
Segmental myoclonus	present	present	absent
Complex/Primitive reflexes			
Suck	Normal or strong	weak or absent	absent
Moro	strong	weak, incomplete	absent
Tonic Neck	slight	strong	absent
Autonomic Function			
Pupils	dilated	constricted	variable, often unequal, fixed dilated
Heart rate	tachycardia	bradycardia	variable
Breathing	Normal or tachypnoea	Periodic or irregular breathing	Irregular breathing, apnoea's
Seizures (clinical)	none	common	uncommon, decerebration with status

Continuous aEEG monitoring (OBM® & BRM3 monitor), can classify brain activity and the presence of clinical and/or electrical seizures. Progress (or lack thereof) of background pattern towards normal is a sensitive marker for prognosis. For further details, refer to guideline on aEEG monitoring- 'EEG(amplitude integrated) monitoring in NICU' CPG JHCH_NICU_14.01.

Neuro-imaging with ultrasound and/or MRI should take place in any infant with NE. Ultrasound can detect structural abnormalities, intraventricular bleeds or can provide evidence of antenatal infections. Although not very sensitive, it can also detect cerebral oedema and sometimes evidence of a stroke. MRI is the optimal imaging mode in newborn infants with NE, with high sensitivity and specificity to diagnose most causes of NE. Patterns of brain injury on conventional T1- and T2-weighted MRI at 1 week after birth due to a perinatal hypoxic event have been shown to predict abnormal neuromotor outcome in early childhood. Diffusion-weighted imaging (DWI) and apparent diffusion coefficient (ADC) changes with HIE injury are most prominent from days 2 through 5. Hence the optimal timing of MRI to detect and classify HIE injury is around day 5 to 7. Current MRI scoring systems use a qualitative description (mild, moderate, severely abnormal) of the posterior limb of the internal capsule (PLIC), basal ganglia and thalami, white matter, and cortical gray matter. For suspected intracranial bleeds or neonatal stroke, MRI imaging can be performed earlier.

Respiratory status

Initial respiratory support is determined by the severity of the metabolic acidosis and the efficacy of the respiratory compensatory mechanisms in place. With a progressing clinical stage of encephalopathy, a weak or absent respiratory drive will determine the need for mechanical ventilation. Seizures during NE are often accompanied by apnoeas, and seizure treatment can affect respiratory drive, both prolonging the need for mechanical ventilation. Severe acidosis can lead to pulmonary hypertension.

Cardiac status

Cardiovascular compromise with NE is due to hypoxic and/or ischaemic damage to the heart and impaired vascular tone and vascular auto-regulation. Clinically, this can present as a pale and poorly perfused newborn, with or without hypotension. The clinical picture can be complicated by hypoxic respiratory failure and pulmonary hypertension. Assessment should include arterial blood pressure monitoring, differential saturation (right hand and feet) and serial cardiac ultrasound. Echocardiography findings include poor cardiac function (low cardiac output, low myocardial velocities), right ventricular dysfunction and pulmonary hypertension. Serum troponin levels can help in diagnosing cardiac damage, but do not help in prognosis. With severe hypoxia, rhythm abnormalities can occur.

Renal status

Acute kidney injury (AKI) is common in HIE, but not in other causes of NE. There is lack of consensus in the definition of AKI in newborns, as accurate diagnosis is difficult in the first day of life. Renal failure can occur in the absence of oliguria or raised creatinine in newborns, and accurate biomarkers of AKI are not yet available. The greatest clinical challenge to making a diagnosis of intrinsic renal dysfunction is separating this clinical entity from pre-renal failure due to hypovolemia and/or severe cardiac dysfunction. A fluid challenge can be useful in distinguishing these entities. A fractional excretion of sodium (Pcr x Una)/(Pna x Ucr) > 3% identifies intrinsic renal damage in an infant more than 48 hours of age. Serial creatinine and electrolyte tests are

required to assess for trends, regardless of the absolute values. Strict attention should be paid to fluid balance and all fluid input, including drugs and blood products must be accounted for. There is no evidence that fluid restriction reduces or prevents cerebral edema in newborns with HIE, but fluid restriction will limit glucose intake and can worsen hypovolemia. Fluid restriction should be limited to infants with AKI and oliguria. In the event of abrupt anuria, consider urinary retention secondary to sedatives and opiates. If a bladder catheter is already in place, make sure it is properly positioned and not occluded.

Liver status

Although the liver often shows evidence of damage in infants with HIE, it rarely leads to liver failure in those situations. Neonatal encephalopathy with liver failure is more often part of a broader systemic disorder, such as infections (Herpes virus, cytomegalovirus, enterovirus), metabolic disease (Tyrosinaemia, Galactosaemia, and urea cycle defects), infiltrative disease (Hemophagocytic lymphohistiocytosis) or drug intoxication (acetaminophen).
Document and follow evidence of liver involvement in HIE (liver enzymes, albumin, bilirubin) until recovery, or extend investigations if there is no obvious perinatal hypoxic event and the clinical course dictates. In all cases of encephalopathy, frequent monitoring of serum glucose is warranted.

Haematological status

Several aspects of a hypoxic-ischaemic event can contribute to haematological abnormalities in infants with HIE. Moderate thrombocytopenia with activated platelets and up-regulation are found inconsistently after hypoxia. Evidence of disseminated intravascular coagulation (DIC) can be present in infants with clinical shock and/or severe hypoxic events. Diagnosis is made by serial evaluation of coagulation profile (APTT, PPT, fibrinogen degradation products and fibrinogen level).

Gastrointestinal status

Feed intolerance and the inability to suck often limits enteral feeding in infants with NE. Infants with HIE can have clinical signs of NEC (Necrotising Enterocolitis) suggestive of ischemia-reperfusion injury with DIC, although exact mechanisms are unclear. Document feed intolerance, clinical signs of NEC, and time to reach self-feeding.

Infectious status

NE can be caused by infections. Most of these infants do not have evidence of a perinatal event. Diagnosis of infectious causes of NE should include blood culture, lumbar puncture, antibody testing, viral PCR studies and various imaging studies.

Supportive treatment for neonatal encephalopathy

Top

For a specific diagnosis of NE, treatment of the underlying cause can help reduce mortality and improve outcome. Infections can be treated with appropriate antibiotics or antivirals and for some metabolic diseases specific treatment and adjusting dietary intake is beneficial. However, for the most common causes of NE (hypoxic-ischemic event, stroke) no specific treatment is available. Cooling of infants after moderate to severe encephalopathy due to intra-partum hypoxia has the ability to reduce the severity of damage that occurred. The section below mainly applies to infants born after a perinatal hypoxic-ischemic event, but general principles would apply to all infants with NE.

Resuscitation

- Follow standard resuscitation principles. Refer to ' Resuscitation of the newborn infant 'JHCH_NICU_1.02 . **If there is evidence of a significant intrapartum hypoxic ischemic insult, leave the overhead heater off**.

Respiration

- Obtain early and frequent blood gases and correct respiratory acidosis with appropriate respiratory support.
- Most newborns after a perinatal hypoxic ischemic event will have normal lung compliance (exceptions include newborns born through meconium).
- Persistent hypoxia is often caused by pulmonary hypertension due to acidosis and high pCO_2.
- In the absence of parenchymal lung disease, aim for normocarbia (pCO_2 35-45) and avoid hypoxia, hyperoxia and/or hypocarbia.

Circulation

- Insert umbilical lines for arterial blood pressure monitoring.
- Use volume for hypovolemia.
- If significant cardiovascular compromise as determined by poor perfusion or low blood pressure is not responsive to volume replacement, obtain a cardiac ultrasound to determine cardiac function and target treatment appropriately. Hypotension due to depressed cardiac function with low blood flow will respond best to dobutamine. Hypotension due to a loss of vascular tone and normal blood flow can respond to dopamine.
- Pulmonary hypertension after hypoxic-ischemia responds to normalising pCO2, acidosis, and normalising blood pressure.
- The use of iNO is contra-indicated in severe left ventricular dysfunction.
- Correct persistent severe metabolic acidosis with targeted circulatory support.
- Sodium bicarbonate in resuscitation or post hypoxic-ischaemic conditions is not recommended.
- Use a formal ECG to assess suspected rhythm abnormalities.

Neurological

- Start continuous aEEG monitoring in any infant with NE.
- Document aEEG background pattern and the presence of seizures for each shift
- Treat seizures initially with phenobarbitone according to seizure guideline. Refer to seizure guideline) 'EEG(amplitude integrated) monitoring in NICU' CPG JHCH_NICU_14.01 for more information.
- Document detailed neurological examination and items of the Sarnat staging daily until full recovery.

- Arrange MRI at day 5-7 for infants with HIE. Earlier may be indicated for specific suspected diagnosis (stroke, bleeding, and malformation).
- Document the neurological examination at discharge.

Renal support and fluid management

- Regular assessment of fluid balance, electrolytes and creatinine should be performed.
- Normal fluid intake should be commenced.
- Infants with acute kidney injury (AKI) and anuria/oliguria should receive insensible loss and urine output replaced as glucose 10% after pre-renal and post-renal causes of oliguria have been excluded.

Haematological

- Obtain Hb, platelet level and coagulation profile (APTT, PPT, fibrinogen degradation products and fibrinogen level) every 12 hours of the first day, and then daily until the values are normal or as otherwise indicated by the clinical condition.
- Administer vitamin K as soon as possible following admission.
- Treat disseminated intravascular coagulation according to international guidelines. (link to guide)
- If evidence of bleeding, administer fresh frozen plasma (FFP).

Gastrointestinal (GI)

- The decision to feed will depend on a clinical assessment of the severity of the NE and associated system dysfunction. Starting amount and rate of enteral feed increment should take into account potential of compromised GI function secondary to hypoxia/ischemia.
- Breast milk is preferred.

Metabolic

- Obtain an early and frequent serum glucose level and correct hypoglycaemia, (refer to 'Hypoglycaemia screening and management' JHCH_NICU_16.01)
- Obtain liver function tests daily until values are normal or as otherwise indicated by the clinical condition.
- Maintain core temperature 36 - 37C, unless therapeutic cooling is initiated.
- Avoid hyperthermia.

Diagnostic blood tests

- Admission blood includes blood gas, FBC (Full blood count), coagulation, electrolytes, Mg (Magnesium), liver enzymes, renal function test, lactate, and troponin
- The frequency of these tests depends on clinical condition. Daily blood tests are needed until the tests are normal and clinical recovery is started.

Cooling Treatment

Cooling for neonatal encephalopathy due to an intrapartum hypoxic event

Following a hypoxic-ischaemic insult, brain cell death occurs in two major phases. The first phase consist of immediate neuronal death due to cellular hypoxia (especially if the insult is severe), followed by a secondary phase of delayed neuronal death. Cell death in the second phase is triggered by a cascade of pathological processes leading to further loss of neurons starting after some hours and extending over days. Therefore a therapeutic 'window of opportunity' exists in the

interval following resuscitation of the asphyxiated newborn, before the secondary phase of impaired energy metabolism and injury is fully established.

Evidence from 11 randomised trials including 1505 term and late preterm newborns with moderate to severe encephalopathy showed a reduction in the combined outcome of mortality or major neurodevelopmental disability at 18 months of age, RR 0.75 (95% CI 0.68 to 0.83). The ability to reduce the severity of damage was most pronounced in the infants with moderate encephalopathy. The main (but infrequent) side effects were sinus bradycardia and thrombocytopenia.

Currently, there is no evidence to support active cooling of infants with mild encephalopathy or those born before 35 weeks. One trial did include newborns with mild encephalopathy, but did not report on outcome for this group separately.

NSW health was has set the following criteria for therapeutic cooling in infants with HIE in a policy directive. <u>All of the following four criteria must be met:</u>

1. More than or equal to 35 weeks gestational age.
2. Less than 6 hours post birth.
3. Evidence of asphyxia as defined by the presence of at least two of the following:

    a) Any acute perinatal event that may result in HIE (i.e. abruptio placentae, cord prolapse, severe FHR abnormality etc.).

    b) Apgar less than 6 at 10 min or continued need for resuscitation with positive pressure ventilation +/- chest compressions at 10 mins.

    c) Cord pH less than 7.0 or base excess of -12 mmol/l or less.

    d) If cord pH is not available, arterial pH less than 7.0 or BE less than -12mmol/L within 60 mins of birth.

4. The presence of moderate or severe encephalopathy

Moderate or severe encephalopathy is defined as encephalopathy with the development of seizures OR presence of moderate to severe signs in at least three of the six categories of the Sarnat staging (Level of consciousness, activity, neuromuscular control, complex/primitive reflexes and autonomic system, see table)

Exclusion criteria include an oxygen requirement greater than 80%, major congenital abnormalities, uncontrolled severe clinical coagulopathy (low platelet count or clinical evidence of abnormal clotting and/or clotting studies which has not responded to appropriate therapy) or a baby unlikely to survive

Although evidence of an intrapartum hypoxic event can be easily diagnosed, the development and progress of clinical encephalopathy is not always clear and it can be difficult to distinguish mild from moderate encephalopathy. aEEG was used in 4 trials (684 patients) as an additional diagnostic tool to help select infants most likely to benefit from therapeutic cooling. Depressed background patterns (lower margin of the aEEG trace < 5µV, or burst suppression/continuous low voltage/flat trace patterns) or the presence of seizures were used to include infants with HIE into the trials.

If in doubt between mild and moderate encephalopathy (and the subsequent eligibility for cooling and the PAEAN study), it is reasonable to wait up to 4 hours and re-assess aEEG and clinical signs of encephalopathy. Until that time, passive cooling is recommended.

Both clinical examination and aEEG have some limitations in accurately predicting prognosis, but combined evaluation has shown to improve predicting prognosis, and likely candidates that could benefit from active cooling. Until we have at least some data on efficacy of active cooling in infants with mild encephalopathy, cooling should be limited to infants who fit all eligibility criteria. However, when in doubt, cooling should be started with the option to stop active cooling at any stage when it becomes clear that the encephalopathy was not as significant as initially predicted.

Refer to CPG 'Cooling for HIE' JHCH_NICU_14.03 for procedure to cool an infant.

Prognosis of neonatal encephalopathy

Top

The prognosis of neonatal encephalopathy is dependent on the underlying cause. In the case of HIE, the outcome can be reasonably predicted based on the Sarnat stage encephalopathy, aEEG findings during admission and abnormalities on MRI. The overall risk of death or severe handicap is 1.6% in grade 1 HIE, 24% in grade 2 HIE and 78% in grade 3 HIE. Most infants (95%) with HIE and severe aEEG background abnormalities (continuous low voltage, flat trace) died or had a severe handicap. With moderate abnormalities this was 64%, and mild or no abnormalities 3.3%.

Recent outcome data in the era of cooling showed that of the infants with moderate to severe encephalopathy, 25% died and 35% of the survivors showed major sensorineural disability.

The long term outcome of neonatal stroke is usually more favourable, although it will depend on the extent and number of brain area's involved.

Appendix 1 Neonatal Encephalopathy Chart

Top

Name:
MRN:
DOB:
Time of birth:

Date							
Day	**1**	**2**	**3**	**4**	**5**	**6**	**Discharge**
Clinical (See table over page)							
Encephalopathy Stage (I-III)							
Clinical Seizures (Y/N)							
Neurological Examination (normal / abnormal)							
Suck Feeds (partial / full)							
Multi-organ Function							
Troponin-T ng/L							
Oliguria (<0.5ml/kg/hour)							
Creatinine µmol/L							
ALT / AST							
INR							
APTT							
aEEG Findings (See figure over page)							
Background aEEG Pattern							
aEEG Seizures (Y/N)							
Comments							
Therapy							
Hypothermia (Y/N) record time ceased							
Phenobarbitone (dose)							
Phenytoin (dose)							
Midazolam (dose)							
Other (dose)							

Formal EEG Results

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_____

Magnetic Resonance Findings

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_____

Name:
MRN:
DOB:
Time of birth:

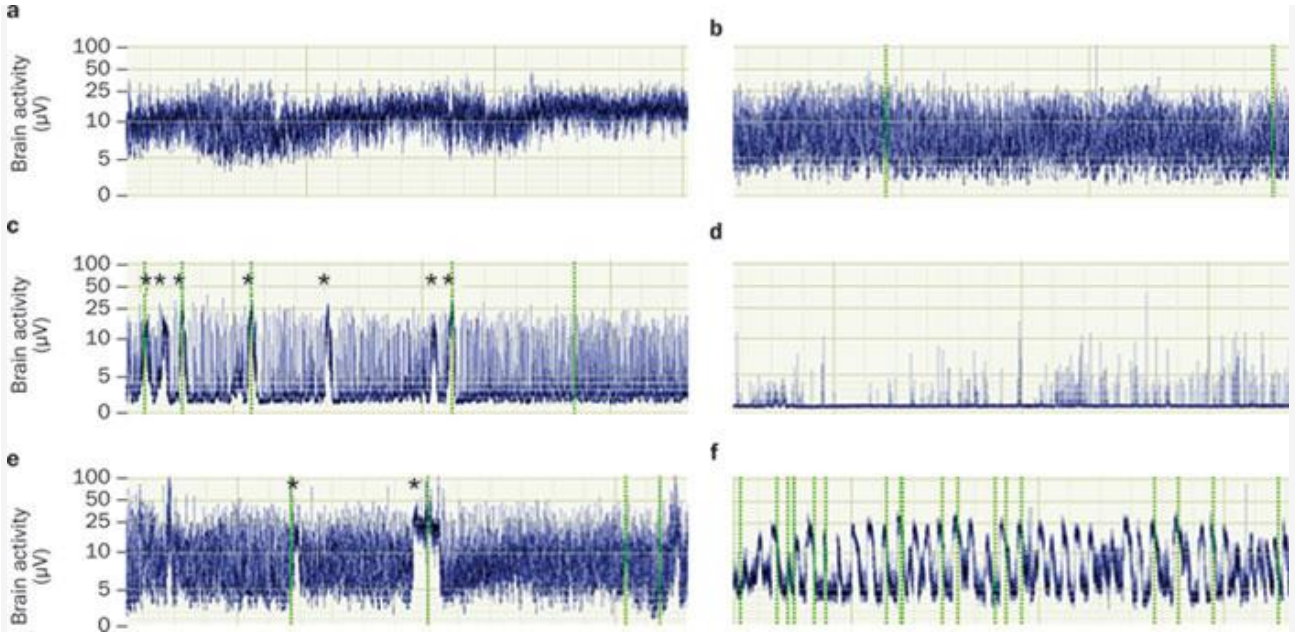
Neonatal Encephalopathy Chart

Table. Criteria for defining mild, moderate and severe encephalopathy.

Category	Stage 1: Mild Encephalopathy	Stage 2: Moderate Encephalopathy	Stage 3: Severe Encephalopathy
Level of consciousness	Hyperalert / staring	Lethargic (reduced response to non painfull stimuli)	Stupor or coma (minimal or no response to painfull stimuli)
Spontaneous activity	Overactive / irritable	Decreased activity	No activity
Posture	Mild distal flexion	Distal flexion	Decerebrate
Mucle Tone	Normal or increased	Reduced trunk and/or extremity tone	None
Primitive reflexes (moro and suck)	Strong suck; low threshold Moro	Weak suck; incomplete Moro	Absent suck or Moro
Autonomic system (pupils, heart rate, respiration)	Pupils dilated; tachycardia; normal respiration or tachypnoea	Pupils Constricted ; bradycardia ; periodic/irregular breathing	Deviated, dilated, or nonreactive to light; variable heart rate; apnoea

Minimum of one symptom in at least 3 categories

Figure. Amplitude integrated EEG pattern (aEEG)



a. Continuous normal voltage
b. Discontinuous normal voltage
c. Burst suppression (with seizures)
d. Isoelectric trace
e. Seizures
f. Saw tooth pattern of status epilepticus

Additional Comments_____
_____
_____
_____

Appendix 2

Blood Tests (to be continued until rewarming)

- Blood gases (arterial line is usually inserted) to be collected initially every 4 hours, then as required by clinical state. This will include blood glucose level, lactate and ionized calcium.
- EUC's (including calcium and magnesium) initially to be collected every 12 hours, and then daily until day 5.
- Full blood count (FBC) initially 12 hourly then as required by clinical status but at least daily until day 5.
- Clotting studies to be collected daily until day 5.
- Troponin level with initial bloods
- Liver function tests (LFT's) as required by clinical status.

Subsequent blood tests as per clinically indicated

On-going management

- Sarnat staging should be assigned on the third day of life as the maximum stage reached since birth.
- Continuous aEEG monitoring is required until the infant is fully rewarmed, and thereafter as per clinical status
- An MRI should be arranged for approximately 7 days of age. Earlier may occasionally be required for withdrawal management
- On day 5-7 the neurological state including reflexes should be formally recorded and this should again be documented prior to discharge. A formal neurodevelopmental assessment tool may be helpful at this stage e.g. Dubowitz or other appropriate term assessment score

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Top

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FEEDBACK

Any feedback on this document should be sent to the Contact Officer listed on the front page.

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