Hypoxic-ischaemic encephalopathy (HIE)

Clinical Guideline Presentation

45 minutes
Towards CPD Hours
References:
Queensland Clinical Guideline: Hypoxic-ischaemic encephalopathy (HIE) is the primary reference for this package.

Recommended citation:

Disclaimer:
This presentation is an implementation tool and should be used in conjunction with the published guideline. This information does not supersede or replace the guideline. Consult the guideline for further information and references.

Feedback and contact details:

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Objectives

At the end of this presentation, the participant will be able to outline:

• Care of the baby with suspected hypoxic-ischaemic encephalopathy (HIE)
• Criteria for commencing therapeutic hypothermia
• Discharge planning considerations
• Parental considerations and information
## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>aEEG</td>
<td>Amplitude-integrated electro-encephalograph</td>
</tr>
<tr>
<td>APTT</td>
<td>Activated partial thromboplastin time</td>
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<tr>
<td>BGL</td>
<td>Blood glucose levels</td>
</tr>
<tr>
<td>BP</td>
<td>Blood pressure</td>
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<tr>
<td>CSCF</td>
<td>Clinical Services Capability Framework</td>
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<tr>
<td>FBC</td>
<td>Full blood count</td>
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<tr>
<td>FGR</td>
<td>Fetal growth restriction</td>
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<tr>
<td>GDM</td>
<td>Gestational diabetes mellitus</td>
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<tr>
<td>HIE</td>
<td>Hypoxic-ischaemic encephalopathy</td>
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<tr>
<td>HR</td>
<td>Heart rate</td>
</tr>
<tr>
<td>INR</td>
<td>International normalised ratio</td>
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<tr>
<td>LoC</td>
<td>Level of consciousness</td>
</tr>
<tr>
<td>LP</td>
<td>Lumber puncture</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
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<td>-------------------------------------------</td>
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<tr>
<td>MRI</td>
<td>Magnetic resonance imaging</td>
</tr>
<tr>
<td>NBST</td>
<td>Newborn bloodspot screening test</td>
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<tr>
<td>NEC</td>
<td>Necrotising enterocolitis</td>
</tr>
<tr>
<td>QCG</td>
<td>Queensland Clinical Guideline</td>
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<tr>
<td>RR</td>
<td>Respiration rate</td>
</tr>
<tr>
<td>RSQ</td>
<td>Retrieval Services Queensland</td>
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<tr>
<td>SpO₂</td>
<td>Peripheral capillary oxygen saturation</td>
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<tr>
<td>TH</td>
<td>Therapeutic hypothermia</td>
</tr>
<tr>
<td>&gt;</td>
<td>Greater than</td>
</tr>
<tr>
<td>&lt;</td>
<td>Less than</td>
</tr>
<tr>
<td>≥</td>
<td>Greater than or equal to</td>
</tr>
<tr>
<td>≤</td>
<td>Less than or equal to</td>
</tr>
</tbody>
</table>
Baby has 

- An acute peripartum or intrapartum event

Can lead to 

- Systemic hypoxaemia and/or
- Reduced blood flow

Can result in 

- HIE

and 

- The potential for significant mortality and long-term morbidity
Incidence

• Queensland 2015–2019:
  ◦ Intrauterine hypoxia and birth asphyxia
    1.3–1.7% of all live preterm and term births
    (not all of these babies developed HIE)

• Internationally:
  ◦ Term intrapartum hypoxia-ischaemia is
    3.7 (range 2.9–8.3) per 1000 term births
  ◦ HIE is 2.5 per 1000 live births
Parents and family

• Regular discussions and meetings
  ◦ Explanation of tests, procedures, drugs, equipment, pain management

• Assist parents to provide care measures (depending on baby’s condition)

• Refer to local support services and provide parent information

• If required, provide palliative and bereavement care
## Risk factors

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal</td>
<td>Thyroid disease, hypertension, GDM, infection, uterine rupture, birthing complications</td>
</tr>
<tr>
<td>Fetal/baby</td>
<td>FGR, low Apgar scores</td>
</tr>
<tr>
<td>Feto-placental</td>
<td>Multiple pregnancy, oligohydramnios, polyhydramnios</td>
</tr>
<tr>
<td>Intrapartum events</td>
<td>Prolonged shoulder dystocia, abnormal fetal heart rate pattern</td>
</tr>
</tbody>
</table>
Resuscitation

- Aim for normothermia until the baby meets the inclusion criteria for therapeutic hypothermia
- Measure paired cord blood gases
- Ensure a capillary, venous or arterial blood gas is taken within the first hour following birth
- Refer to QCG: *Neonatal resuscitation*
Diagnosis

• Significant peripartum or intrapartum hypoxic-ischaemic events include:
  ◦ Uterine rupture
  ◦ Placental abruption
  ◦ Cord prolapse
  ◦ Amniotic fluid embolism
  ◦ Fetal exsanguination from vasa praevia or massive feto-maternal haemorrhage
Diagnosis

• No biomarker
• May have history of hypoxic and/or ischaemic injury during the perinatal and/or intrapartum period
• Absence of intrapartum sentinel event does not exclude the diagnosis of HIE
Clinical features

• Abnormal state of consciousness
• Reduced spontaneous movements
• Respiratory difficulties
• Poor tone
• Abnormal posturing
• Abnormal primitive reflexes
• Seizures
• Poor feeding
Diagnostic criteria

• Fetal umbilical artery acidaemia
  ◦ pH < 7.0 and/or base deficit ≤ minus 12 mmol/L

• Examination
  ◦ Consistent with mild, moderate or severe encephalopathy
Diagnostic criteria (cont’d)

• Onset of multisystem organ failure may include a combination of:
  ◦ Renal injury
  ◦ Hepatic injury
  ◦ Haematologic abnormalities
  ◦ Cardiac dysfunction
  ◦ Metabolic derangements
  ◦ Gastrointestinal injury
Investigations

• Routine–repeat daily or more often
  ◦ Blood gas
  ◦ Electrolytes, calcium, glucose and lactate
  ◦ FBC including platelets
  ◦ Coagulation profile–INR and APTT
  ◦ Septic work-up–blood culture, LP
  ◦ Liver and renal function: day 1–2
  ◦ MRI at day 5–10

• If moderate/severe HIE– aEEG if available
Differential diagnosis

• Consider other causes of encephalopathy, for example:
  ◦ Metabolic abnormalities
  ◦ Congenital abnormalities
  ◦ Meningitis
  ◦ Hypoglycaemia
  ◦ Hyperbilirubinaemia
  ◦ Chronic placental insufficiency
  ◦ Other causes of newborn seizures/encephalopathy e.g. intracranial haemorrhage, perinatal stroke, drug withdrawal
Observation and monitoring

If acute perinatal/intrapartum hypoxia ischaemia as evidenced by:

- Apgar score ≤ 5 at 10 minutes
- Blood gas either:
  - pH < 7.00, or
  - Base excess ≤ minus 12 mmol/L
- Mechanical ventilation or ongoing resuscitation for ≥ 10 minutes

Commence:

- Continuous monitoring:
  - HR, RR and SpO₂
  - BP (if manual 15 minutely)
- Hourly (or more frequent):
  - Temperature: avoid hyperthermia (> 37.5 °C)
  - HIE staging criteria

Discuss eligibility for TH with neonatologist
Clinical staging of HIE

• Modified Sarnat and Sarnat scoring
  ◦ Provides information on magnitude of injury and prognosis
  ◦ Commence as soon as possible after resuscitation and stabilisation
  ◦ Continue for at least first six hours
  ◦ Baby may deteriorate and move from stage 1 (mild) to stage 2 (moderate)

• Discuss with neonatologist
# HIE clinical staging

<table>
<thead>
<tr>
<th>Category</th>
<th>Mild (Stage 1)</th>
<th>Moderate (Stage 2)</th>
<th>Severe (Stage 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LoC</td>
<td>Hyperalert</td>
<td>Lethargic</td>
<td>Stupor or coma</td>
</tr>
<tr>
<td>Spontaneous activity</td>
<td>Normal or increased</td>
<td>Decreased</td>
<td>None</td>
</tr>
<tr>
<td>Posture</td>
<td>Mild distal flexion</td>
<td>Distal flexion, complete extension</td>
<td>Decerebrate</td>
</tr>
<tr>
<td>Tone</td>
<td>Normal or slightly increased</td>
<td>Hypotonia (focal or general)</td>
<td>Flaccid</td>
</tr>
<tr>
<td>Primitive reflexes</td>
<td>Weak suck; strong Moro</td>
<td>Weak suck or incomplete Moro</td>
<td>Absent suck or Moro</td>
</tr>
<tr>
<td>Autonomic system</td>
<td>Pupils equal and reacting to light; tachycardia</td>
<td>Constricted pupils, bradycardia or periodic/irregular breathing</td>
<td>Deviated/dilated/non-reactive pupils, variable heart rate or apnoea</td>
</tr>
<tr>
<td>Seizures</td>
<td>None</td>
<td>Common, focal or multifocal</td>
<td>Uncommon</td>
</tr>
</tbody>
</table>
Therapeutic hypothermia criteria

- Evidence of perinatal/intrapartum hypoxia:
  - Apgar score ≤ 5 at 10 minutes
  - Ongoing resuscitation at 10 minutes
  - pH < 7.00 or a base deficit ≤ minus12 mmol/L on blood gas within 60 minutes of birth
- Evidence of encephalopathy at any time in first 6 hours
- Signs associated with moderate/severe encephalopathy
- ≥ 35 weeks gestational age and birth weight ≥ 1800 g
- Able to begin cooling before 6 hours of birth
- No contraindication, e.g. uncontrolled bleeding, uncontrolled hypoxia, imminent withdrawal of life support planned
- If mild encephalopathy, < 35 weeks or < 1800 g discuss with neonatologist
Therapeutic hypothermia–stabilisation

If baby likely to meet TH criteria:

• Refer to QCG: *Neonatal stabilisation for retrieval*
  ◦ Contact RSQ as required

• Nurse baby with nappy only on open care cot with radiant warmer off

• Insert venous access and nasogastric tube

• Collect blood samples
Therapeutic hypothermia—clinical standards

• Commence within 6 hours of birth before secondary reperfusion injury
• Cool for 72 hours at target temperature
• Target core temperature of 33–34.0 °C within 2 hours
• Continuous core (rectal) temperature monitoring (if available) or axilla temperature every 30 minutes
Therapeutic hypothermia—clinical practice

• Passive cooling:
  ◦ Open care system with radiant warmer off
  ◦ Nappy only on baby

• Active cooling:
  ◦ Servo-controlled and rewarming mattress (preferred)
  ◦ Manual using covered cool packs (10 °C)—observe for skin necrosis
Therapeutic hypothermia—clinical practice

- NBM—risk of NEC
- Sedation/pain relief—low dose morphine
- Monitor medications as metabolism of most drugs altered
- Monitor for thrombocytopenia, sinus bradycardia
## Multi-organ considerations

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<thead>
<tr>
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<th>Consideration</th>
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</thead>
</table>
| **Respiratory** | • Avoid hyperoxia and hypocapnia  
• Maintain SpO\textsubscript{2} ≥ 92%                                           |
| **Cardiovascular** | • Hypotension, shock, cardiomegaly, arrhythmias, heart failure, ischaemia may occur  
• Avoid hypertension or hypotension                                           |
| **Infection**   | • May co-exist with HIE  
• Commence empirical antibiotics  
• Refer to QCG: *Early onset Group B streptococcal disease*                 |
| **Neurological** | • Assess for encephalopathy  
• Manage seizures  
• Refer to QCG: *Neonatal seizures*                                          |
| **Neuro-development** | • Reduce environmental stimuli  
• Manage pain, stress and comfort  
• Involve parents                                                            |

Queensland Clinical Guidelines: Hypoxic-ischaemic encephalopathy (HIE)
Multi-organ considerations

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| Renal          | • Oliguria, haematuria, proteinuria, myoglobinuria, polyuria or renal failure may occur  
                 | • IV fluids and monitor fluid balance                                        |
| Metabolic      | • Hypo/hyperglycaemia, hypocalcaemia, hyponatraemia, hyponatraemia, lactic acidosis may occur  
                 | • Maintain BGL within normal ranges                                          |
|                | • Refer to QCG: *Newborn hypoglycaemia*                                      |
| Haematology    | • Thrombocytopenia, thrombosis, elevated nucleated red blood cells may occur  
                | • Perform coagulation profile                                                |
| Gastrointestinal| • Risk of NEC  
                       | • NBM                                                                        |
Rewarming after TH

- Rewarm over 12–16 hours at 0.5 °C every 2 hours
- Monitor rectal temperature for 6 hours after return to normal
- Monitor for apnoea, hypotension, seizures
Prognosis

• Early prognosis of long term outcome is difficult—best determined by using multiple modalities
  ◦ Clinical assessment
  ◦ Neurological examination
  ◦ aEEG and/or EEG
  ◦ MRI
Follow-up

• Plan a discharge and follow-up meeting with the parents
  ◦ Discuss what happened to their baby, their treatment and ongoing follow-up
  ◦ Provide written information

• Moderate to severe HIE:
  ◦ Provide follow-up for at least 2 years
  ◦ Ensure appropriate assessment and referrals

• Mild HIE—consider follow up also