Queensland Clinical Guidelines

Translating evidence into best clinical practice

Maternity and Neonatal **Clinical Guideline**

Hypoglycaemia–newborn

Queensland Government

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The Department of Health acknowledges the Traditional Custodians of the lands, waters and seas across the State of Queensland on which we work and live. We also acknowledge First Nations peoples in Queensland are both Aboriginal Peoples and Torres Strait Islander Peoples and pay respect to the Aboriginal and Torres Strait Islander Elders past, present and emerging.

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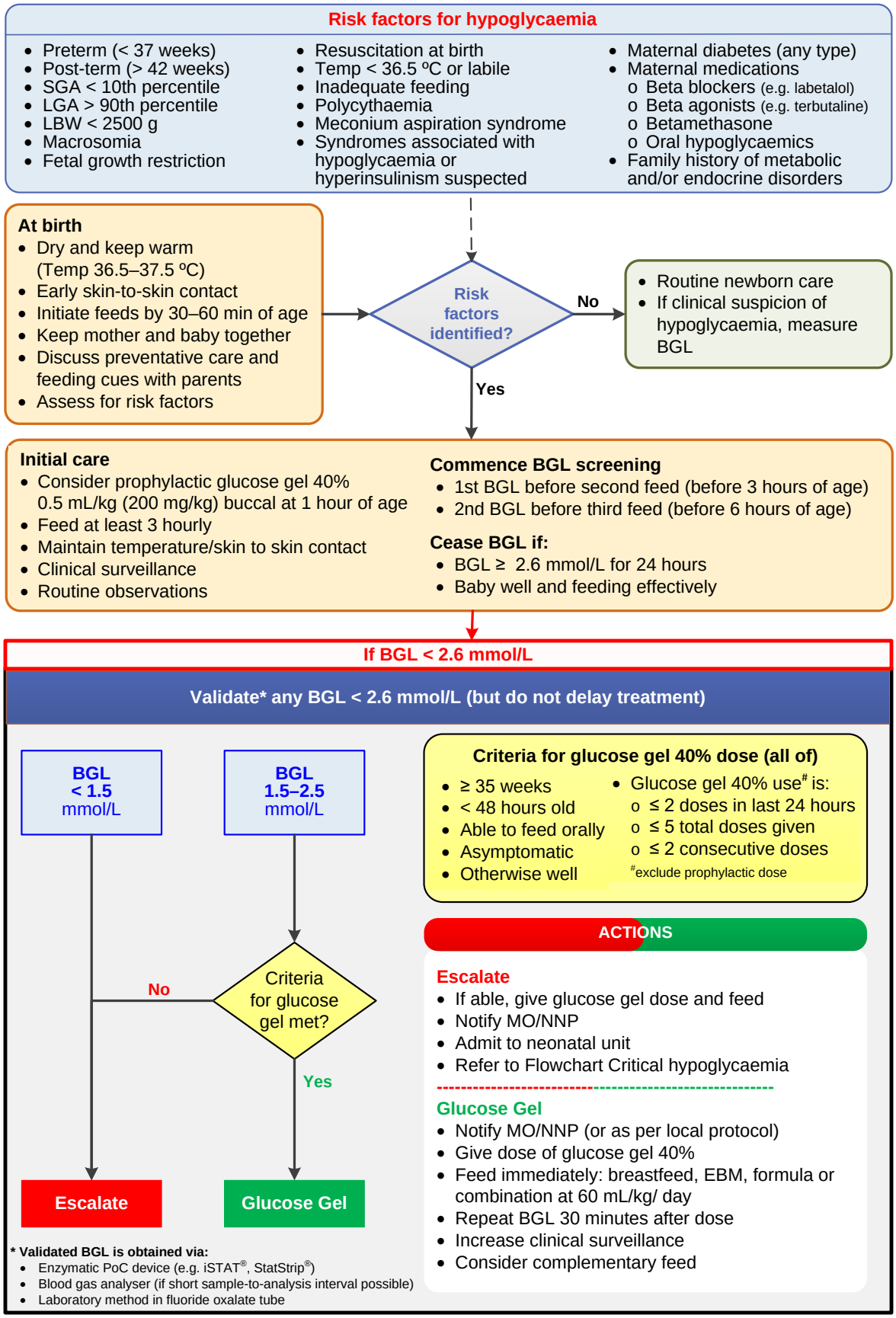
Flowchart: Management of the well at-risk baby in first 48 hours of life



Flowchart: F23.8-4-V1-R28

BGL: blood glucose level, **EBM:** expressed breast milk, **Hx**: history **IV:** intravenous, **LBW:** low birth weight, **LGA:** large for gestational age, **MO:** medical officer, **NNP:** neonatal nurse practitioner, **PoC:** point of care, **RSQ:** Retrieval Services Queensland, **SGA:** small for gestational age, **<** less than, **>** greater than, **≥** greater than or equal to

Flowchart: Critical neonatal hypoglycaemia in first 48 hours

Critical hypoglycaemia: BGL < 1.5 mmol/L, recurrent, prolonged or symptomatic

Validate* any BGL < 2.6 mmol/L

Urgent
- Do not delay treatment
- Urgent medical consultation
- Admit to neonatal unit–contact RSQ as required
- Validate* screening BGL
- Collect diagnostic samples
- If able, give glucose gel and feed while establishing other treatments

IV glucose therapy initiation
- Establish IV (PVL/UVC) access
- Commence 10% glucose IV infusion at 60 mL/kg/day
  - If symptomatic or BGL not improving, commence at 80 mL/kg/day
- Give 10% glucose 1 mL/kg IV bolus
  - May repeat 1 mL/kg if BGL remains low
  - Initial 2 mL/kg IV bolus may be indicated in some clinical circumstances
- If IV access delayed > 15 minutes give glucagon 200 microgram/kg IM or subcut
- Recheck BGL no later than 30 minutes after IV bolus

Glucagon
- If after 10% glucose IV bolus (as indicated) BGL not improved, or baby symptomatic, urgently give glucagon 200 microgram/kg IV/IM/subcut stat

Other treatment principles
- To achieve immediate increase in glucose delivery, increment IV glucose *rate* before glucose *concentration*
- Monitor risk of fluid overload
  - Fluids not exceeding 100 mL/kg/day on day 1
  - Monitor serum sodium
- Increase IV glucose concentration to 12% or step-wise to higher concentration
  - If concentration > 12% glucose give via UVC/CVL
- If GIR > 8 mg/kg/minute in 1st 24 hours or baby hyponatraemic consider glucagon infusion
- Feeds–continue if not contraindicated
- Medications - refer to NeoMedQ

Escalate and investigate
- If glucose > 7 mg/kg/minute
- Baby > 48 hours of age
- BGL refractory or requires medication to control

BGL monitoring
- 30 minutes after:
  - Start/change to IV glucose (concentration or rate)
  - Medication for hypoglycaemia
- Individualise at neonatologist discretion
  - Repeat hourly until BGL target reached
  - Then, 3–6 hourly before feeds

Weaning of treatments (in order)
- Gradually reduce IV therapy while establishing full enteral feeds
- When full feeds established, wean
  - Glucagon and then hydrocortisone

Glucose mg/kg/minute	mL/kg/day			
%	60	80	100	120
10%	4.2	5.6	6.9	8.3
12%	5	6.7	8.3	10
14%	5.8	7.8	9.7	11.7
16%	6.7	8.9	11.1	13.3
18%	7.5	10	12.5	15
20%	8.3	11	13.9	16.7

Diagnostic samples
- Venous or arterial blood only
- During hypoglycaemic episode
- Before treatment

Blood gas including electrolytes, glucose, haemoglobin, haematocrit and lactate

Priority 1	Insulin Cortisol Acyl-carnitine profile
Priority 2	Growth hormone
Priority 3	Plasma amino acids Ammonium Pyruvate Beta Hydroxybutyrate

Urine (post hypoglycaemic episode)
Metabolic screen

Ceasing BGL monitoring
(All BGL measurements in mmol/L)

If complex glycaemic support required, then at neonatologist discretion

Recommended criteria
- Baby is well and feeding effectively.
- Other treatments ceased
- BGL target achieved pre-feed (every 3-6 hours) for 24 hours after treatments ceased

BGL targets
- Within first 48 hours of life BGL ≥ 2.6
- 48–96 hours of life BGL ≥ 3.0
- > 96 hours of life BGL ≥ 3.5
- If known hypoglycaemic disorder BGL ≥ 4.0

*** Validated BGL is obtained via:**
- Enzymatic PoC device (e.g. iSTAT®, StatStrip®)
- Blood gas analyser (if short sample to analysis interval possible)
- Laboratory method in fluoride oxalate tube

BGL: blood glucose level, **CVL:** central venous line, **GIR:** glucose infusion rate, **IM:** intramuscular, **IV:** intravenous, **NNP:** neonatal nurse practitioner, **PoC:** point of care, **PVL:** peripheral venous line, **RSQ:** Retrieval Services Queensland, **subcut:** subcutaneous, **UVC:** umbilical venous catheter, **>** greater than, **<** less than, **≥** greater than or equal to

Flowchart: F23.8-3-V10-R28

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Abbreviations

BGL	Blood glucose level
EBM	Expressed breastmilk
GIR	Glucose infusion rate
IV	Intravenous
LCHADD	Long-chain 3-hydroxyacyl-CoA dehydrogenase deficiency
MCADD	Medium chain acyl-CoA dehydrogenase deficiency
MO	Medical officer
NNP	Neonatal nurse practitioner
PoC	Point of care
RSQ	Retrieval Services Queensland
SGA	Small for gestational age

Definitions

Clinical judgement	The application of practice, experience, knowledge and continuous critical analysis to communication, diagnosis and decision making.[1]
Critical hypoglycaemia	Used in this guideline to refer to a baby with any of: • Symptoms of hypoglycaemia irrespective of BGL o BGL may be more or less than 2.6 mmol/L • Severe, recurrent or prolonged hypoglycaemia • Other circumstances of concern (e.g. unwell, inadequate feeding) where the BGL is at the lower end of the normal range • Hypoglycaemia not responsive to initial treatment
Hypoglycaemia	Blood glucose level (BGL) less than target for age o In the first 48 hours of life, less than 2.6 mmol/L
Hypoglycaemia–prolonged	Hypoglycaemia lasting longer than 48 hours.
Hypoglycaemia–recurrent	More than 3 sequential episodes of BGL less than target for age in the first 48 hours of life of less than 2.6 mmol/L.
Hypoglycaemia–severe	BGL less than 1.5 mmol/L or symptomatic.
Macrosomia	Birth weight greater than the 90th percentile or intrauterine growth beyond 4.5 kg.
Nadir	The lowest point (e.g. lowest blood glucose level).
Neonatologist	Local facilities may if required, differentiate the roles and responsibilities assigned in this guideline to a “neonatologist, paediatrician, medical officer or neonatal nurse practitioner” according to their specific practitioner group requirements.
Neonatal Unit	Area for babies requiring care and management ranging from standard newborn care to special or intensive care.[2] This may be an area of the maternity ward while waiting for Retrieval Services Queensland (RSQ).
Validated BGL	Blood glucose level (BGL) measured using one of: • An enzymatic point of care (PoC) device (e.g. iSTAT®, StatStrip®) • A blood gas analyser if a short (few minutes) sample-to-analysis interval is achieved • A laboratory based method, with sample sent in a fluoride oxalate tube Note: non-enzymatic PoC glucose meters are considered as screening devices and are not sufficient for validation.

1 Introduction

Neonatal hypoglycaemia is a common event affecting 5–15% of babies in the immediate postnatal period; occurring more frequently (up to 50%)[3] in certain at-risk groups (e.g. infants of diabetic mothers, small for gestational age, preterm, large for gestational age[4]).

This guideline is organised around identification and management in the first 48 hours of life of the 'at-risk otherwise well newborn baby', followed by management of the baby who experiences (or progresses to) critical hypoglycaemia [refer to Definitions] and requires more complex management. Ongoing management beyond the first 48 hours of life requires consultation with experts (neonatal, endocrine, and/or metabolic), and management that is tailored to the underlying cause(s) and severity.

As the causes and severity of neonatal hypoglycaemia are varied, deviation from guideline recommendations may be appropriate in individual circumstances, and the use of clinical judgement is essential.

1.1 Physiology and clinical significance

Table 1. Normal physiology

Aspect	Physiology
Glucose as energy source	• Glucose is the primary energy substrate for the newborn brain[5] o Although alternate energy substrates and adaptive mechanisms can be utilised, their depletion leads to energy failure and brain injury[5] • Both symptomatic and asymptomatic hypoglycaemia are associated with adverse neurological outcomes when compared with euglycaemic babies[6]
Metabolic transition in healthy term babies	• A wide range of BGLs are documented as physiologically normal in the term healthy baby in the first five days of life[7-9] • By 96 hours of age BGL is similar to adult concentrations (4.2 mmol/L)[8,10] • Refer to Appendix A: Postnatal changes in newborn blood glucose levels
Clinical significance	• No single BGL identified that causes brain injury[11] o Extent of injury influenced by severity, duration and recurrence of hypoglycaemia, and availability and baby's ability to use other substrates (e.g. lactate, fatty acids and ketone bodies)[5] o Glucose variability, lability and rate of glucose concentration change associated with worse adverse outcomes[5,12] • Early magnetic resonance imaging (MRI) after BGL less than 1.2 mmol/L demonstrates white matter injury and haemorrhage, cortical injury in the occipital and posterior parietal regions (involved in visual processing), restricted diffusion in the occipital lobes, and basal ganglia/thalamic lesions[5]
Longer term outcomes	• Outcome data impacted by accuracy of measurement methods, ongoing controversy over definitions of blood glucose thresholds, varying outcome measures reported at different timepoints and heterogeneity between studies[5] • May present in neonatal period as encephalopathy with poor feeding, lethargy, seizures, hypothermia or respiratory distress[13] • May be associated with an increased risk of specific cognitive deficits[14] o In early childhood (2–5 years) visual motor impairment and executive dysfunction o In later childhood (6–11 years) general cognitive impairment and literacy and numeracy problems

1.2 Principles of hypoglycaemia management

Table 2. Principles of hypoglycaemia management

Aspect	Consideration
Clinical judgement	• BGL gradually increases in the first 4 days of life with different trajectories for different babies[8] • Use clinical judgement, and consider the individual circumstances of the baby and the BGL trend when applying BGL parameters to management
BGL parameters to *guide* management[5,7,8]	• Although a wide range recognised as normal, consensus view is: o During 0–48 hours of life aim for BGL 2.6 mmol/L or more o After 48 hours to 96 hours of life, aim for BGL of at least 3.0 mmol/L o After 96 hours of life aim for BGL of at least 3.5 mmol/L • If known or suspected persistent hypoglycaemic disorder (e.g. endocrine or metabolic disorder): aim for BGL greater than or equal to 4.0 mmol/L at any age of life (or as recommended by metabolic or endocrine specialist)
Neonatologist/ paediatrician consult indicated	• If at any time the BGL is: o Less than 2.6 mmol/L on any three occasions **or** o Less than 1.6 mmol/L on two occasions **or** o Less than 3.0 mmol/L after 48 hours of age o Less than 3.5 mmol/L after 96 hours of age
Blood sample collection	• Provide pain relief prior to heel prick sample collection (e.g. breastfeeding/ expressed breastmilk (EBM) or oral sucrose) o No known effect of sucrose on BGL • If possible, collect during skin to skin contact • Follow local protocols regarding correct collection techniques • For screening BGL use capillary blood from heel prick or venepuncture • For diagnostic test consider venepuncture or arterial sample
BGL screening	• Preferentially, use a point of care (PoC) device validated for use in neonates[15-18] (e.g. iSTAT®, StatStrip®) • Non-enzymatic devices may be unreliable at lower BGL[16]
Validate screening BGL less than target	• Management plans are dependent on validated BGL and/or the clinical condition of the baby[17] • Validate a screening BGL with a diagnostic test (but do not delay treatment) if: o BGL less than target (essential and urgent if less than 2.0 mmol/L in the first 48 hours of life?) o BGL borderline and critical risk factors or clinical signs of hypoglycaemia[16] • Diagnostic tests to validate a screening BGL include[19,20]: o An enzymatic point of care analyser (e.g. iSTAT®, StatStrip®) o Blood gas analyser (with short collection to analysis interval) o Laboratory specimen in fluoride oxalate tube • Non-enzymatic PoC devices are not sufficient for validation

1.3 Clinical signs

Hypoglycaemia can be asymptomatic.[5] Measure the BGL and consider the clinical signs in the differential diagnosis. Clinical signs may overlap or be concurrent with other newborn disorders.

Table 3. Clinical signs

Aspect	Sign
Neurogenic[5,21,22]	• Jitteriness or persistent tremor • Breathing—irregular and rapid • Sweating, pallor, irritability
Neuroglycopenic[21,22]	• Poor feeding, lethargy, apathy • Hypotonia • Abnormal cry—weak or high-pitched • Seizures • Changes in level of consciousness–stupor, coma
Other[5]	• Apnoea, tachypnoea, cyanosis, bradycardia, hypothermia

1.4 Risk factors, causes and mechanism of action

Some risk factors predispose a baby to hypoglycaemia through several mechanisms (e.g. fetal growth restriction (FGR)). If multiple risk factors are present, extra surveillance is required.

Table 4. Causes and mechanism of action

Mechanism	Risk factors for hypoglycaemia in newborn
Failure of metabolic adaptation[5,23]	• Maternal drugs (dosage, pharmacokinetics and administration to birth interval may affect hypoglycaemic effect on baby) o Beta-blockers (e.g. labetalol, atenolol)[24,25] if administered in the third trimester until birth o Beta-agonists (e.g. terbutaline for uterine hyperstimulation) if administered within 48 hours of birth. ▪ No evidence of effect when administered more than 48 hours before birth[26,27] o Antenatal betamethasone may cause transient fetal adrenal suppression[28-30] if administered after 36 weeks gestation and within 24 hours of birth[31], or multiple courses given o Oral hypoglycaemics if administered in the third trimester until time of birth • Perinatal hypoxia-ischemia • Polycythaemia/hyperviscosity
Reduced energy reserves[21]	• Prematurity (less than 37+0 weeks gestation) • Post term (more than 42+0 weeks gestation, or less if placental insufficiency) • Intrauterine growth restriction/placental insufficiency from any cause • Small-for-gestation age (SGA) (birth weight less than 10th percentile) • Low birth weight (less than 2500 g) • Delayed or inadequate feeding
Increased energy demands[21]	• Cold stress • Seizures • Hypoxic-ischemic encephalopathy • Sepsis • Heart failure • Respiratory distress
Endocrine[5,23]	• Hyperinsulinism (transient)) o Large-for-gestation (birth weight greater than 90th percentile) o Maternal diabetes (Type I, Type II or gestational diabetes mellitus) o Prenatal stress-induced (small for gestational age, maternal hypertension, pre-eclampsia, eclampsia) • Genetic congenital hyperinsulinism disorders (e.g. glutamate dehydrogenase enzyme mutation (GLUD1), ABCC8, KCNJ11 mutations) • Failure of counter-regulation o Hypopituitarism, (adrenocorticotropic hormone (ACTH) and/or growth hormone (GH) deficiency) congenital adrenal hyperplasia (and other primary adrenal disorders)
Inborn errors of metabolism[5,32]	• Disorders of carbohydrate metabolism o Disorders of gluconeogenesis o Glycogen storage disease o Galactosemia • Disorders of fatty acid oxidation o Medium-chain acyl-CoA dehydrogenase (MCHAD) deficiency o Very long-chain acyl-CoA dehydrogenase (VLCHAD) deficiency o Carnitine palmitoyltransferase 1 (CPT-1) deficiency • Disorders of amino acid metabolism o Maple syrup urine disease • Short-chain hydroxyacyl CoA dehydrogenase (SCHAD) deficiency
Syndromes[5,7]	• Associated with hypoglycaemia or hyperinsulinism (e.g. Beckwith-Wiedemann Syndrome, congenital hyperinsulinaemic hypoglycaemia) • Family history of genetic form of hypoglycaemia

2 Well baby with risk factors (in first 48 hours)

This section is relevant to an otherwise well baby at or beyond 35+0 weeks gestation in the first 48 hours of life who is able to suck feed.

2.1 Risk minimisation and screening

Table 5. Initial screening and risk minimisation

Aspect	Consideration
At birth	• Dry and keep warm—maintain temperature 36.5–37.5ºC per axilla • Recommend early skin to skin contact[22,33] • Initiate feeds[22,33] within 30–60 minutes of birth o Breastfeeding[33] or EBM preferable o Recommend feeding in response to cues, with no more than three hours between feeds[33] o Discuss feeding cues • Review history and identify risk factors for hypoglycaemia o Multiple risk factors increase risk of hypoglycaemia
Breastmilk feeding	• If required, support three hourly hand expressing in the first 24 hours until feeding is established[34] • Consider referral to lactation consultant • If available, consider human donor milk as per local protocols • Refer to Queensland Clinical Guideline: *Establishing breastfeeding*[35]
Formula feeding	• If maternal choice or breastmilk not available o Commence at 60–75 mL/kg/day as tolerated (with maternal consent)
BGL screening	• If risk factors identified, commence BGL screening[36] o 1st BGL before second feed and not later than three hours of age[33] o 2nd BGL before third feed and not later than six hours of age • If first two BGL greater than or equal to 2.6 mmol/L, continue to screen before every second feed (at least every six hours) for the first 24 hours of life • If any BGL less than 2.6 mmol/L refer to Section 2.2 Initial management of otherwise well baby (BGL 1.5–2.5 mmol/L)
Clinical surveillance	• Clinical observations as per Neonatal Early Warning Tool (NEWT) • Maintain high level of suspicion for clinical signs associated with hypoglycaemia, especially if multiple risk factors identified o Consider the number and type of risk factors when planning care • Utilise strategies to prevent heat loss/maintain temperature (e.g. skin to skin, delay first bath, warm wraps)
Routine care	• Provide parents/carers with ongoing information about the assessment, management and expected course of baby's condition • Avoid separation of mother and baby • Promote skin to skin contact • For care considered routine or standard refer to Queensland Clinical Guideline: *Standard care*[37] o Includes for example: privacy, consent, decision making, sensitive communication, medication administration, staff education and support, culturally appropriate care

2.1.1 Prophylactic glucose gel 40%

Table 6. Prophylactic glucose gel 40%

Aspect	Consideration
Evidence summary	• A systematic review and meta-analysis (4 studies; n=3329) reported glucose gel given to at-risk babies shortly after birth and before diagnosis of hypoglycaemia, significantly reduced the risk of hypoglycaemia compared with placebo gel[38] • Number needed to treat (NNT)=17 to prevent one case of hypoglycaemia[4] • Risk of major neurological disability at two years 'probably reduced'[4] • No difference in other outcomes (e.g. number of hypoglycaemic episodes per baby, need for intravenous (IV) treatment, separation of mother and baby, breastfeeding duration) although sample sizes insufficient to detect effects for some outcomes[4] • No evidence of adverse effects on establishment of breastfeeding or gut microbiome[39,40]
Recommendation	• Recommend a prophylactic dose of glucose gel 40% before first feed for well babies with risk factors for hypoglycaemia o Especially if multiple risk factors identified o BGL not required prior or following administration • Refer to NeoMedQ: *Glucose gel 40%*[41]
Administration	• Follow with feed (does not preclude breastfeeding attempts prior to prophylactic administration) o Offer support and assess effectiveness of feed • Additional treatment doses can be administered subsequently o A prophylactic dose of glucose gel 40% is not included in the criteria for administration of a treatment dose of glucose gel 40% • Refer to Table 9. Glucose gel to increase glycaemic support

2.2 Initial management of otherwise well baby (BGL 1.5–2.5 mmol/L)

A staged approach to management and further investigation in the first 48 hours of life is indicated for a hypoglycaemic baby with a BGL greater than or equal to 1.5 mmol/L.

Table 7. Initial management in otherwise well baby

Aspect	Consideration
Initial treatment (BGL 1.5–2.5)	• If baby is well and feeding, administer a dose of glucose gel 40% o Refer to NeoMedQ: *Glucose gel 40%*[41] • Immediately follow with breastfeed, EBM, formula or a combination at 60 mL/kg/day o Assess feeding effectiveness over entire duration of feed • Notify medical officer/neonatal nurse practitioner (MO/NNP) immediately (or as per local protocols) • Validate a screening BGL less than 2.6 mmol/L with a diagnostic test (but do not delay treatment to do so)
Monitoring	• Repeat BGL 30 minutes after glucose gel 40% dose • Continue o Support of feeding (breastfeeding is preferable) o BGL monitoring before feeds o Clinical surveillance • Perform clinical examination of the baby to identify risk factors and clinical signs associated with hypoglycaemia o Refer to Queensland Clinical Guideline: *Assessment–routine newborn*[42]
Escalation	• If any subsequent BGL 1.5–2.6 mmol/L refer to Section 2.3 Glycaemic support

2.3 Glycaemic support

If BGL less than 1.5 mmol/L refer to Section 3 Critical hypoglycaemia.

2.3.1 Enteral feeding

Insufficient as a single treatment strategy when validated BGL is less than 1.5 mmol/L.

Table 8. Feeding strategies to increase glycaemic support

Aspect	Consideration
Usual feeding	• Standard feeding regimen for at risk baby o Minimum every 3 hours (or more frequently if displaying feeding cues) o Breastmilk and/or formula
Complimentary feed	• Complimentary feed (breastmilk and/or formula) may be indicated if: o One BGL less than 2 mmol/L **or** o Two or more BGL are less than 2.6 mmol/L
Feeding strategies	• Full top-up complimentary feed at 7.5 mL/kg/feed every 3 hours o Equivalent to 60 mL/kg/day on day one of life • Half-top-up complimentary feed at 3.75 mL/kg/day every 3 hours o Equivalent to 30 mL/kg/day on day one of life o May be indicated if baby has been vomiting or breastfed prior • If following breastfeed and half-top up, BGL remains 1.5–2.5 mmol/L, then give full-top up at the next feed
Weaning complimentary feeds	• Commence weaning (e.g. initially halve quota) when BGL 2.6 mmol/L or more and effective feeding established • Monitor BGL pre-feed each time a weaning change is made • If complimentary feeding recommenced, usual recommendation is to continue for 12 hours before next weaning attempt
Monitoring	• Continue pre-feed BGL monitoring while complimentary feeding • After complimentary feeds ceased, monitor BGL 6 hourly pre-feed for 24 hours
Escalation considerations	• Repeated episodes of hypoglycaemia (BGL 1.5–2.5 mmol/L) despite feeding strategies and initial management with glucose 40% gel • Repeated BGL around the lower limits of target BGL may also be of concern and require further investigation and treatment

2.3.2 Glucose gel 40% for treatment of hypoglycaemia

Refer to NeoMedQ: *Glucose gel 40%*[41] for dose and administration requirements. Glucose gel 40% is insufficient as a single treatment strategy when validated BGL is less than 1.5 mmol/L.

Table 9. Glucose gel to increase glycaemic support

Aspect	Consideration
Indication	• Effective adjunct to enteral feeding in the first 48 hours of life during periods of transient hypoglycaemia[43,44] • **Immediate** breastfeeding after administration improves quality of subsequent breastfeeds and reduces requirement for further treatment[43] • Interim treatment while other glycaemic support is initiated (e.g. IV access established) irrespective of previous doses
Criteria for glucose gel 40%	• Confirm **all** criteria prior to administering dose of glucose gel (exclude any prophylactic dose in count of doses) ☑ Baby is more than 35 weeks gestational age ☑ Baby is less than 48 hours old ☑ Baby is able to receive feed orally ☑ Baby is asymptomatic ☑ Baby is otherwise well ☑ 2 or fewer doses of glucose gel 40% in previous 24 hours ☑ 2 or fewer consecutive doses of glucose gel 40% in previous 48 hours ☑ 5 or fewer dose of glucose gel 40% in previous 48 hours
Administration	• Follow glucose gel 40% oral dose with enteral feed • Refer to NeoMedQ: *Glucose gel 40%*[41] o Refer to Section 2.3.1 Enteral feeding
Monitoring[45]	• Repeat BGL 30 minutes after administration of glucose gel 40%
Escalation	• Any BGL less than 1.5 mmol/L • If criteria for glucose gel 40% not met, refer to Section 2.4 Criteria for escalation • Repeated episodes of hypoglycaemia (BGL 1.5–2.5 mmol/L) despite feeding strategies and initial management with glucose gel 40% • Maintain awareness that repeated BGL around the lower limits of normal parameter (around 2.6 mmol/L) may also be of concern and require further investigation and treatment

2.4 Criteria for escalation

Refer to Flow Chart: Management of the well at risk newborn baby in first 48 hours and Section 3. Critical hypoglycaemia and initiate treatment if any of the following:

- BGL less than 1.5 mmol/L *irrespective* of number of doses glucose gel 40% already given
- BGL 1.5–2.5 mmol/L and any of the following (excluding prophylactic dose of glucose gel 40%):
  - 3 doses glucose gel 40% in the past 24 hours
  - 2 consecutive doses glucose gel in the past 48 hours
  - 6 doses glucose gel 40% in the past 48 hours

2.5 Ceasing BGL monitoring

Following complex glycaemic support (e.g. requirement for glucagon or other medication), individualise decisions in consultation with a MO/NNP. Consider if a 6 hour fast is indicated before ceasing BGL monitoring.

Table 10. Ceasing BGL monitoring

Lowest BGL	Recommended criteria for ceasing BGL monitoring
BGL 2.6 mmol/L or more in first 24 hours of life	**Baby with risk factors, without hypoglycaemia** • Baby is well • Baby is feeding effectively • Cease after 24 hours of age
BGL 1.5–2.5 mmol/L within first 48 hours	**Baby with hypoglycaemia** • Baby is well • Baby is feeding effectively • If term baby: o Gastric tube feeding/complimentary feeding discontinued o IV glucose ceased • After treatments ceased, target BGL achieved pre-feed (every 3 to 6 hours) for further 24 hours • Refer to Section 1.2 Principles of hypoglycaemia management
Critical hypoglycaemia or complex management	**Baby required complex glycaemic support/management** • Cease BGL monitoring at neonatologist/paediatrician discretion • Suggested criteria o Baby is well o Baby is feeding effectively o Target BGL stable according to age and clinical condition • Refer to Section 1.2 Principles of hypoglycaemia management **Ongoing management** • Long term endocrine or metabolic conditions may require BGL home monitoring • Consider if six hour fast test is indicated o Refer to Section 4.3 Six hour fast test

3 Critical hypoglycaemia

This and subsequent sections are relevant to babies who have/are any of the following:

- Less than 35+0 weeks gestation
- Not feeding effectively (or formula is indicated but consent not provided)
- Not responding to first line glycaemic support (i.e. glucose gel, enteral feeding)
  - Refer to Section 2.4 Criteria for escalation
- Hypoglycaemia persists or presents at more than 48 hours of age
- Severe, ongoing, recurrent or symptomatic hypoglycaemic episodes

3.1 Initial treatment for critical hypoglycaemia

A BGL less than 1.5 mmol/L or unrecordable, and/or baby unwell or symptomatic is a clinical emergency. Initiate treatment urgently. Management in consultation with a neonatologist/paediatrician is required.

Table 11. BGL less than 1.5 mmol/L

Aspect	Consideration
Urgent	• Do not delay treatment o Admit to neonatal unit [refer to Definitions] o Contact Retrieval Services Queensland (RSQ) if required • If not contraindicated, administer glucose gel and feed (breastfeed preferred) while establishing other treatments • Validate screening BGL • Collect diagnostic blood and urine samples o Refer to Appendix D Investigations for neonatal hypoglycaemia • Refer to Table 2. Principles of hypoglycaemia management • Prevent/manage hypothermia
IV glucose therapy (IVT)	• Establish vascular access (peripheral/umbilical) and commence IVT • Commence 10% glucose IV infusion at 60 mL/kg/day[46] o If symptomatic commence at 80 mL/kg/day • Calculate IV glucose in mg/kg/minute o Refer to Appendix B Glucose infusion rates (GIR)
Difficult IV access	• If access is difficult or delayed more than 15 minutes o Administer 200 micrograms/kg of glucagon intramuscular or subcutaneous stat o Refer to NeoMedQ: *Glucagon*[47] • Contact RSQ for advice regarding cannulation options
IV glucose bolus	• Give 10% glucose 1 mL/kg (100 mg/kg) IV bolus[19,34] o 2 mL/kg may be appropriate in some clinical circumstances (e.g. baby moribund, seizing, or BGL extremely low) o Repeat BGL no later than 30 minutes after IV bolus • If indicated (e.g. BGL remains low), repeat 10% glucose at 1 mL/kg • Use sparingly and consider the risk of rebound hypoglycaemia o Not indicated for well baby who is feeding, and who has with risk factors or mild hypoglycaemia (BGL 1.5 mmol/L or more in first 48 hours of life)
Glucagon	• If after 10% glucose IV bolus, baby symptomatic or BGL not at target o Urgently give glucagon by preferred route o Refer to NeoMedQ: *Glucagon*[47]
Clinical examination	• Review maternal history for risk factors • Review neonatal history (e.g. birth details, feeding, BGLs, vital signs) • Perform physical examination (note indicators of pituitary/adrenal disease) • Identify relevant syndromic features • Identify clinical signs of hypoglycaemia
Feeds	• If not contraindicated, continue feeds • Commence gavage feeds as indicated (e.g. if ineffective breastfeed) • If maternal choice, give formula feeds • Consider complimentary feeds
BGL monitoring	• 30 minutes after any change to concentration, or to volume of IV glucose or glucagon is administered o If possible via enzymatic PoC device or blood gas analyser • Then every 3–6 hours pre-feed

3.2 Next line treatment principles for critical hypoglycaemia

Use clinical judgement when determining the need for specific treatments in response to critical hypoglycaemia.

Table 12. Ongoing management after severe hypoglycaemia

Aspect	Consideration
Increase volume of glucose	• Increase fluid *volume* before the *concentration* of glucose as this will result in an immediate change in glucose delivery rate • Increase in 20 mL/kg/day increments to maximum 100 mL/kg/day in first 24 hours o 10% glucose increased from 60 mL/kg/day to 80 mL/kg/day provides a 33% increase in glucose (glucose infusion rate (GIR) increased by 1.4 mg/kg/minute) o A temporary increase in volume may be required while solution of increased glucose concentration is prepared
Increase concentration of glucose	• Increase IV glucose concentration to 12% or step-wise to a higher concentration o Glucose 12% provides a 20% increase in glucose over 10% glucose (if infusion rate constant) • If greater than 12% glucose required, administer via central catheter, umbilical vein catheter or peripherally inserted central catheter (PICC) • Refer to Appendix B Glucose infusion rates (GIR)
Fluid management	• Consider the risk of hyponatraemia and fluid overload o More likely at or beyond 100 mL/kg/day (less in some babies) especially in first 24 hours of life • Review serum sodium and other electrolyte levels regularly • If signs of fluid overload or hyponatraemia, consider o Increased glucose concentrations at lower infusion rates o Medication (e.g. glucagon) to enable reduction in fluid intake • Include enteral feed volume (if given) in total daily fluid calculations • If enteral feeds contributing significant volume to total intake (e.g. 20–25%), consider inclusion in GIR calculation • Online calculators may be of assistance
Glucagon	• If GIR greater than 8 mg/kg/minute, consider glucagon infusion to: o Minimise interference with the establishment of breastfeeding o Avoid fluid overload o Lessen pancreatic over stimulation with high glucose delivery • Refer to Table 13. Medications
Persistent or suspected long-term hypoglycaemia	• Consider hydrocortisone if: o Laboratory or clinical evidence suggest hypoadrenalism o Insufficient response to glucagon o Baby is also hypotensive • Need for higher glucose concentrations may indicate hyperinsulinism[33] • Non-responsive to glucagon (may indicate glycogen storage disease, liver disease or depleted liver glycogen stores) • Baby with endocrine deficiency (counter-regulatory hormones i.e. growth hormone and adrenocorticotropic hormone (ACTH)/cortisol) or inborn error of metabolism more likely to require only 4–6 mg/kg/minute of glucose to maintain euglycaemia
Escalation	• Discuss baby's management with neonatologist (via RSQ if necessary) if: o Frequent or prolonged hypoglycaemia o Glucose infusion concentration is greater than 12% o GIR is greater than 8 mg/kg/minute o Glucagon or hydrocortisone or other medication is required o Difficulties with IV access (avoid exhausting all IV sites prior to escalation) o Additional areas of concern identified

3.3 Medications for critical hypoglycaemia

Refer to Queensland Clinical Guidelines NeoMedQ[41,47-50] for detailed medication information including doses mode of action, precautions, side effects and care of baby.

Table 13. Medications

Aspect	Consideration
Context	• If BGL does not normalise after glucose gel or IV glucose, medications may be indicated • Take blood samples immediately before commencing medications while baby is hypoglycaemic o Do not delay treatment while awaiting results • Consider discussion with a neonatologist, paediatric endocrinologist or paediatric metabolic physician by contacting RSQ
Glucagon[47]	• Indicated for babies with refractory hypoglycaemia when liver glycogen stores are available (as increases gluconeogenesis and glycogenolysis)[19] • Effective for babies of women with diabetes or other hyperinsulinaemic conditions proven to be refractory to intravenous glucose infusion • May be less likely to be effective in babies with fetal growth restriction (may be due to lower glycogen stores)[51] • Ineffective in glycogen storage disease type 1, or if liver glycogen stores severely depleted (e.g. asphyxia) or inadequate (e.g. significant liver disease) • If IV access delayed or difficult, may be given by intramuscular (IM) or subcutaneous • BGL should rise within one hour of commencing infusion and last approximately two hours[51] • Commence concomitant intravenous glucose infusion to avoid rebound hypoglycaemia (which may be common after glucagon[51])
Hydrocortisone[50]	• Reduces peripheral glucose utilisation and increases gluconeogenesis • Has a slower response than glucagon • May be first line choice if: o Concurrent hypotension o Suspected hypopituitarism or hypoadrenalism (including if less than 33+0 weeks gestation)
Diazoxide[49]	• Potassium channel activator that inhibits insulin release from the pancreas • If persistent hyperinsulinaemic hypoglycaemia, use to wean from glucose infusion and for long-term management in consultation with a paediatric endocrinologist • Consider risk of adverse effects (e.g. pulmonary hypertension) and monitor fluid intake/consider fluid restriction[52,53] o Risk of pulmonary hypertension increased if perinatal stress hyperinsulinism (e.g. asphyxia, prematurity, SGA
Hydro-chlorothiazide[47]	• Diuretic given in conjunction with diazoxide to prevent fluid retention • Inhibits pancreatic release of insulin
Octreotide[23,48]	• Hyperinsulinaemic hypoglycaemia is known or suspected o Not usually commenced in the newborn period–consult with paediatric endocrinologist

3.4 Weaning treatments after critical hypoglycaemia

Weaning is more complex when glycaemic requirements are significant. Seek advice from a neonatologist as required (via RSQ if necessary) to establish BGL targets relevant to the baby's condition. If baby has known hypoglycaemic disorder, aim for BGL of 4 mmol/L or more. Use clinical judgement to tailor recommendations to the circumstances.

Table 14. Weaning treatment

Aspect	Recommendation
Order of weaning	1. Wean IV glucose and increase to full feeds (appropriate for day of age) 2. When full feeds achieved, wean glucagon (if used) 3. Then wean hydrocortisone (if used) • If difficult weaning/concerns, consult with neonatologist (via RSQ if necessary) for discussion with paediatric endocrinologist or metabolic specialist
Weaning IV glucose	• Gradually reduce IV glucose as enteral feeds increase o If GIR is greater than or equal to 8 mg/kg/minute, reduce the infusion by 2 mg/kg/minute every six hours (as tolerated) o If GIR is less than 8 mg/kg/minute, more frequent decreases may be tolerated • Before and during weaning, continue to monitor BGL and consider: o Glucose concentration and volume of fluid being infused (mL/kg/day) o How well the baby's feeding is establishing o Medications the baby is receiving to treat hypoglycaemia • Monitor BGL 6 hourly pre-feed for at least 24 hours after ceasing o Refer to 2.5 Ceasing BGL monitoring
Weaning glucagon	• Initially wean every 6 hours for 24 hours o If glucagon is more than 20 microgram/kg/hour, then wean in 5 microgram/kg decrements o If glucagon is 10–20 microgram/kg/hour, then wean in 2 microgram/kg/hour decrements o If glucagon is 10 microgram/kg/hour or less, then wean in 1 microgram/kg/hour decrements • If during weaning increased glycaemic support is required (e.g. increase of glucagon, increase in glucose delivery) then suspend weaning for 12 hours • Monitor BGL 3–6 hourly pre-feed for at least 24 hours after ceasing o Refer to 2.5 Ceasing BGL monitoring
Follow-up	• Consider if six hour fast test is indicated o Refer to 4.3 Six hour fast test

4 Severe, prolonged, recurrent or persistent hypoglycaemia

Investigate a baby who has experienced severe, prolonged, recurrent or atypical hypoglycaemia.[33,54,55]

Consult early with a neonatologist (via RSQ if not accessible within service line) regarding:

- Need for endocrinologist/metabolic specialist involvement
- Ongoing management and/or transfer to tertiary unit
- Selection and interpretation of investigations
- Any doubt/concern for baby (prior to discharge)

4.1 Indications for investigation

Table 15. Indications to investigate

Indication	Consideration
Clinical presentations	• After 48 hours of age[54] o Symptomatic hypoglycaemia[36,54] o Need for glucose IV to treat • Seizures or altered level of consciousness • Inability to consistently maintain pre-feed BGL greater than or equal to targets for (approximate) hours of age: o Refer to Section 1.2 Principles of hypoglycaemia management • Unusual presentation of hypoglycaemia or baby with no known risk factors
Severe hypoglycaemia	• BGL that was less than 1.5 mmol/L in first 6 hours of life in the absence of maternal diabetes, prematurity or very low birth weight (less than 1500 g) • Persistent or recurrent hypoglycaemia despite glucose IV greater than or equal to 7–8 mg/kg/minute • Treatment with medication required
Late/early hypoglycaemia	• BGL less than 2.6 mmol/L onset after 24 hours of life • Early onset, persistent or any hypoglycaemia recurrent after 48 hours
Family history	• Genetic hypoglycaemia • Inborn errors of metabolism in parent or sibling,(e.g. MCAD[22], LCHAD deficiency) or other fatty acid oxidation defect) • Endocrine disorders (congenital hyperinsulinism, adrenal, pituitary) • Sudden infant death syndrome[36] • Reye's syndrome[36] • Developmental delay[36]
Anomalies	• Presence of associated anomalies (e.g. cranial or facial malformations, microcephalus; exomphalos, severely low birth weight for gestation, midline defects, micropenis and/or other variations in sex characteristics)[36]

4.2 Investigations

Conditions causing hypoglycaemia may occur concurrently, (e.g. hyperinsulinaemia with low cortisol due to prematurity), low cortisol and growth hormone due to a pituitary disorder with perinatal hyperinsulinism. If recommended by neonatologist, metabolic specialist or endocrinologist, investigations may be targeted to the suspected underlying cause. If cause unknown, perform entire test panel in Appendix D: Investigations for neonatal hypoglycaemia.

Table 16. Investigation

Aspect	Consideration
Pathology tests	• Refer to Appendix C: Preparing glucose concentrations for infusion for recommended tests and their priority of ordering • Preferentially collect venous or arterial samples • Take immediately **before** treatment while baby is hypoglycaemic
Hyper-insulinaemic state[23]	• Diagnosis is made on the basis of increased insulin action and/or inadequate suppression of plasma insulin during either spontaneous or fasting-induced hypoglycaemia[23] • Evidence of excessive insulin action at the time of hypoglycaemia[23]: o Suppressed plasma β-hydroxybutyrate (less than 1.8 mmol/L) o Suppressed plasma free fatty acids (less than 1.7 mmol/L) o Inappropriately large glycaemic response to glucagon (1.7 mmol/L or more) o Increased glucose infusion rate required to maintain euglycemia above normal for age (greater than 8 mg/kg/minute for neonates) • Usually transient but may be persistent and require long-term treatment
Cortisol[7,36]	• More than 200 nanomole/L is likely to be a normal response o May be blunted in preterm baby, hyperinsulinism or prolonged hypoglycaemia of any cause • A lesser response may suggest hypothalamic, pituitary or adrenal dysfunction
Growth hormone[36,56]	• 7 micrograms/L (20 milli-international units/L) or more is a normal response during hypoglycaemia in a term baby o May be blunted in preterm[57] • A lesser response may suggest hypothalamic or pituitary dysfunction
Ammonia	• If greater than 100 micromole/L consider metabolic disorder (e.g. urea cycle defect) or hyperinsulinaemia hyperammonaemia syndrome[58]

4.3 Six hour fast test

Table 17. Six hour fast test

Aspect	Consideration
Rationale	• To determine if baby can maintain normoglycaemia in a fasted state following discharge • Aims to unmask o Persistent hyperinsulinaemic conditions o Endocrine deficiencies o Inborn errors of metabolism[7] o Hypoglycaemia despite medication at discharge (e.g. diazoxide and hydrochlorothiazide) • Refer to Table 15. Indications to investigate
Suggested indications	• Any of: o GIR at any time greater than 7–8 mg/kg/minute o Glucagon o Hydrocortisone for hypoglycaemia o Discharge on diazoxide and hydrochlorothiazide or octreotide is intended o Recurrent hypoglycaemia after 48 hours o Any uncertainty about aetiology of hypoglycaemia • If any uncertainty regarding need, discuss with neonatologist
Performance of test	• Six hours duration unless otherwise advised by metabolic/endocrinology specialist • Conduct while receiving discharge medications (e.g. diazoxide and hydrochlorothiazide) if these have been recommended • Check BGL at four, five and six hours post feed (omit feeds during test)
Target BGL for 6 hour fast test	• As for parameters used to guide management • If conducted: o After 48 hours to 96 hours of life, BGL of at least 3.0 mmol/L o After 96 hours of life BGL of at least 3.5 mmol/L • If known or suspected persistent hypoglycaemic disorder (e.g. endocrine or metabolic disorder), BGL greater than or equal to 4.0 mmol/L (or as recommended by metabolic or endocrine specialist)
Actions	• If baby symptomatic between scheduled BGL measures, or does not meet target BGL for 6 hour fast test o Perform investigations as to the cause and then feed baby o Continue BGL monitoring o Delay discharge of baby o Consult with neonatologist (via RSQ if required) for advice • If baby asymptomatic and BGL greater than or equal to target mmol/L throughout, finish test and feed baby • If BGL less than target, baby requires further assessment and management before discharge

5 Discharge planning

Commence discharge planning for babies who have experienced hypoglycaemia after birth (less than target BGL for age) at the earliest opportunity.

Table 18. Discharge planning

Aspect	Consideration
Planning	• Review babies with repeated intermittent episodes of hypoglycaemia and consider if a six hour fast test is indicated o Seek advice from a neonatologist as indicated o Refer to Section 4.3 Six hour fast test • Review the results of all investigations before discharge as some babies may have more than one aetiology o If diagnosis uncertain at time of discharge, make follow-up arrangements
Discharge criteria	• If baby less than 48 hours of age: o Pre-feed BGL is greater than 2.6 mmol/L for three feed-fast cycles • If known hypoglycaemic condition and baby 48 hours of age or more o Pre-feed BGL is greater than 4 mmol/L for three feed-fast cycles • Six hour fast test performed (if indicated), and baby able to maintain BGL or receiving treatment
Parent education	• Discuss causes, risks, potential sequelae and management • Include signs that require escalation and the escalation plan • Refer to Queensland Clinical Guideline parent information: *Hypoglycaemia in a newborn baby*[59]
Follow-up	• Usual follow-up with general practitioner and child health nurse • If symptomatic, severe, recurrent or atypical hypoglycaemia include follow up by: o Paediatrician or neonatologist o Endocrinologist or metabolic specialist as indicated • Arrange other follow up as per local protocols
Reducing risk in subsequent pregnancies	• Maternal lifestyle—healthy weight and diet management • Genetic counselling/family history • Glycaemic/diabetes management o Refer to Queensland Clinical Guideline: *Gestational diabetes mellitus*[60]

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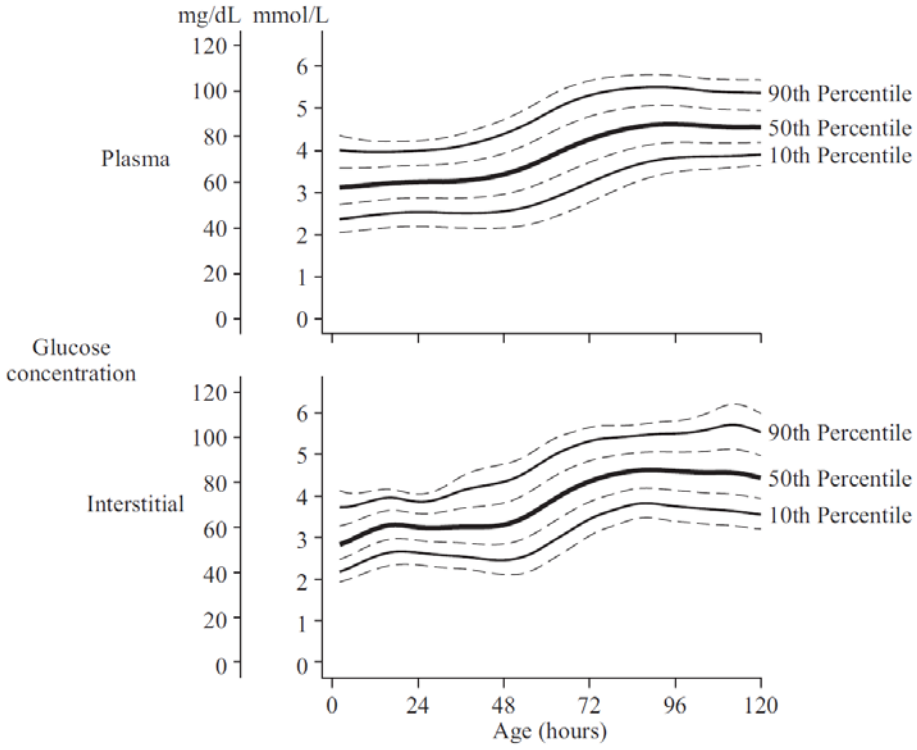
Appendix A: Postnatal changes in newborn blood glucose levels

Hours since birth	10th percentile plasma BGL (approx.)
48 hours	2.6 mmol/L
Around 72 hours	3.0 mmol/L or more



Glucose percentiles

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Appendix B: Glucose infusion rates (GIR)

How to calculate GIR (mg/kg/minute) when mL/hour are known (method 1)*

$$\mathbf{GIR\ (mg/kg/minute)} = \frac{\%\ \boldsymbol{glucose\ being\ infused} \times \boldsymbol{rate\ of\ infusion\ (mL/hour)}}{\boldsymbol{Weight} \times \mathbf{6}}$$

Example–GIR for 4.5 kg baby having 18.75 mL/hour of 12 % glucose

$$\mathbf{GIR\ (mg/kg/minute)} = \frac{\%\ \boldsymbol{glucose\ being\ infused} \times \boldsymbol{rate\ of\ infusion\ (mL/hour)}}{\boldsymbol{Weight} \times \mathbf{6}}$$

$$= \frac{\mathbf{12\%} \times \mathbf{18.75}\ \boldsymbol{mL/hour})}{\mathbf{4.5}\boldsymbol{kg} \times \mathbf{6}}$$

$$= \mathbf{8.34\ mg/kg/minute}$$

OR

How to calculate GIR (mg/kg/minute) when mL/kg/day are known (method 2)*

$$\mathbf{GIR\ (mg/kg/minute)} = \frac{\%\ \boldsymbol{glucose\ being\ infused} \times \boldsymbol{rate\ of\ infusion\ (mL/kg/day)}}{\mathbf{144}}$$

Example–GIR for 4.5 kg baby having 100mL/kg/day of 12 % glucose

$$\mathbf{GIR\ (mg/kg/minute)} = \frac{\%\ \boldsymbol{glucose\ being\ infused} \times \boldsymbol{rate\ of\ infusion\ (mL/kg/day)}}{\mathbf{144}}$$

$$= \frac{\mathbf{12\%} \times \mathbf{100}\ \boldsymbol{mL/kg/day}}{\mathbf{144}}$$

$$= \mathbf{8.34\ mg/kg/minute}$$

GIR quick reference for commonly used concentrations*

Glucose mg/kg/minute				
Glucose %	**60 mL/kg/day**	**80 mL/kg/day**	**100 mL/kg/day**	**120 mL/kg/day**
10	4.2	5.6	6.9	8.3
12	5	6.7	8.3	10
12.5	5.2	6.95	8.68	10.4
14	5.8	7.8	9.7	11.7
15	6.25	8.3	10.42	12.5
16	6.7	8.9	11.1	13.3
18	7.5	10	12.5	15
20	8.3	11	13.9	16.7

***Subtract any other infusions or calculate separately if they contain other concentrations of glucose**

Appendix C: Preparing glucose concentrations for infusion

How to prepare increased concentrations of glucose

Glucose concentration required	Glucose 10% volume (100 mg/mL)	Glucose 50% volume (500 mg/mL)
12%	95 mL	5 mL
12.5%	93.75 mL	6.25 mL
14%	90 mL	10 mL
15%	87.5 mL	12.5 mL
16%	85 mL	15 mL
18%	80 mL	20 mL
20%	75 mL	25 mL

How to calculate increased concentrations of glucose

Formula to increase concentration of 10% glucose and make a 100 mL solution

$$\textbf{Step 1.}\ \textbf{Volume of high concentration mL} = \frac{\textbf{total volume mL} \times (\textbf{desired concentration}\% - \textbf{lower concentration}\%)}{(\textbf{high concentration}\% - \textbf{lower concentration}\%)}$$

$$\textbf{Step 2.}\ \textbf{Volume of low concentration mL} = \textbf{desired volume mL} - \textbf{high concentration volume mL}$$

$$\textbf{Step 3.}\ \textbf{Volume of desired concentration mL} = \textbf{high concentration mL} + \textbf{lowconcentration mL}$$

Example–to prepare 100 mL of 12% glucose for infusion

$$\textbf{Step 1.}\ \textbf{Volume of high concentration mL} = \frac{\mathbf{100\ mL} \times (\mathbf{12}\% - \mathbf{10}\%)}{(\mathbf{50}\% - \mathbf{10}\%)} = \frac{\mathbf{200}}{\mathbf{40}} = \mathbf{5\ mL}$$

$$\textbf{Step 2.}\ \textbf{Volume of low concentration mL} = \mathbf{100\ mL} - \mathbf{5\ mL} = \mathbf{95mL}$$

$$\textbf{Step 3.}\ \mathbf{100\ mL} = \mathbf{5\ mL}\ (\mathbf{50}\%) + \mathbf{95\ mL}(\mathbf{10}\%)$$

Notes:

- Glucose 50% contains 50 grams per 100 mL or 0.5 grams (or 500 mg) per 1 mL
- Glucose 10 % contains 10 grams per 100 mL or 0.1 grams (or 100 mg) per 1 mL
- Rounding final volumes of each concentration of glucose up and down may be required for practical purposes
- **Remove** the volume equivalent to the 50% glucose to be added from the bag of 10% glucose before adding the 50% glucose solution

Appendix D: Investigations for neonatal hypoglycaemia

Identify *Neonatal hypoglycaemia* on the request form and ask for urgent testing. Blood volumes are additive when more than one assay is requested*

Blood	**Specimen collection DURING hypoglycaemic episode, BEFORE treatment**			
Assay	**Priority**	**Volume***	**Pathology Queensland container**	**Comments**
Lactate Glucose	**1**	0.25 mL	blood gas syringe for VBG (or volume appropriate to analyser in a capillary tube) 	0.2 mL in blood gas syringe if using iSTAT (**BOTH** CG4+ and CG8+/Chem8+) Or if lactate and glucose only, 0.5 mL in fluoride oxalate
Electrolytes Hb & HCT	3			
Lactate & Glucose only	**1**	0.5 mL	fluoride oxalate (paed grey top) tube 	
Acylcarnitine	**1**	0.4 mL	lithium heparin no gel (paed dark green top) tube 	Newborn blood spot screening card (heel prick) is not a preferred specimen, it provides only a partial acylcarnitine profile and does not permit plasma amino acid profile.
Plasma amino acid profile	3			
Insulin Cortisol	**1**	0.5 mL	serum separator (paed gold top) tube 	Avoid haemolysis as artifactually lowers insulin
Growth hormone	2	0.5 mL		
Beta-hydroxy-butyrate	3	0.5 mL		If electrolytes not performed on VBG/iSTAT, ELFT can be requested with this tube
Ammonium	3	0.5 mL	EDTA (paed pink/purple top) tube 	No other specimen type is acceptable
ACTH	As advised	0.5 mL		The tube used for ammonium may be used for ACTH if all remaining plasma is frozen immediately following ammonium analysis
Pyruvate	3	0.5 mL (ideally 1 mL)	perchlorate tube  **THEN**  Perchloric acid is corrosive and must not be swallowed, nor allowed to come int contact with skin, eyes nor clothing. Flush immediately with water if contact occurs and seek prompt medical advice.	No other specimen type is acceptable • Perchloric acid tube (in date) must be obtained from laboratory • Collect blood initially into lithium heparin tube or lithium heparin (blood gas) syringe, mix, and decant 0.5 mL to 1 mL into perchloric acid tube without delay • Screw lid tightly, and invert until blood is brown and there is obvious precipitation of protein. No visible red blood is to remain • Handwrite details on inner tube, do not affix any label nor tape • Place into outer tube and tighten lid • Labels may be affixed to outer tube only. • Return tube to laboratory as soon as possible
Urine	**Specimen collection: immediately following hypoglycaemic episode (may collect after treatment)**			
Metabolic screen	1	5 mL		Treatment can commence before collection but specimen must be first urine following hypoglycaemia

ELFT: electrolytes and liver function test, **VBG:** venous blood gas

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