Local Guideline

John Hunter Children's Hospital

NSW GOVERNMENT Health Hunter New England Local Health District

Hypoglycaemia Screening and Management in Neonates

Sites where Local Guideline and Procedure applies	Neonatal Intensive Care Unit (NICU) JHCH
This Local Guideline and Procedure applies to:	
1. Adults	No
2. Children up to 16 years	No
3. Neonates – less than 29 days	Yes
Target audience	All clinicians caring for infants in NICU
Description	Provides guidance for the clinical investigation and management pathways for hypoglycaemia in infants

Go to Guideline

Keywords	NICU, SCU, JHCH, neonate, newborn, neonatal, hypoglycaemia, blood glucose, BGL, blood sugar, BSL, monitoring, glucose
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Replaces existing document?	Yes
Registration number and dates of superseded documents	JHCH_NICU_16.01 Hypoglycaemia Screening and Management

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 PD2020_018 Recognition and management of patients who are deteriorating
- NSW Health Policy Directive PD 2017_013 Infection Prevention and Control Policy
- NSW Health Policy Directive PD2017_032 Clinical Procedure Safety
- HNELHD Policy Compliance Procedure PD2013_043:PCP 31 Medication Safety in HNE Health

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PURPOSE AND RISKS

This local guideline has been developed to provide guidance to clinical staff in Neonatal Intensive Care Unit at John Hunter Children's Hospital to recognise, diagnose and manage infants with hypoglycaemia and ensure that the risks of harm to infants are identified and managed.

The risks are:

- *Injury to infant, particularly long-term neurological damage*
- *Inappropriate monitoring of infants at risk of hypoglycaemia*
- *Delayed identification of hypoglycaemia in infants*

These risks are minimised by:

- *Recognition and diagnosis of infants with symptoms or risk factors associated with hypoglycaemia*
- *BGL levels targeted at ≥2.6 mmol/l to prevent long-term neurological damage*
- *Infants receiving treatment for hypoglycaemia according to the hypoglycaemia flow diagram applicable to late preterm/term infants indicated for screening*

Any unplanned event resulting in, or with the potential for injury, damage or other loss to infants/staff/family as a result of this procedure must be reported through the Incident Management System and managed in accordance with the NSW Health Policy Directive PD2020_020: Incident Management Policy. This would include unintended injury that results in disability, death or prolonged hospital stay.

*It is mandatory for staff to follow relevant: "Five moments of hand hygiene", infection control, moving safely/safe manual handling, documentation practices and to use HAIDET for patient/carer communication: **H**and hygiene **A**cknowledge, **I**ntroduce, **D**uration, **E**xplanation, **T**hank you or closing comment.*

Risk Category: *Clinical Care & Patient Safety*

CLINICAL PROCEDURE SAFETY LEVEL

Every clinician involved in the procedure is responsible for ensuring the processes for clinical procedure safety are followed. The following level applies to this procedure (click on the link for more information):

Level 1 procedure

CONTENT

HYPOGLYCAEMIA SUMMARY

- Significant and/or prolonged hypoglycaemia in the newborn can lead to neurodevelopmental impairment
- Establish early and frequent feeds in in newborns at risk for hypoglycemia
- Blood glucose levels should be monitored for at least 36 hours in newborns at risk for hypoglycemia
- Blood glucose levels <2.6 mmol/l (moderate) and ≤1.6 mmol/l (severe) are used as action levels

GUIDELINE

While not requiring mandatory compliance, staff must have sound reasons for not implementing standards or practices set out within guidelines issued by HNE Health, or for measuring consistent variance in practice.

Introduction

Glucose is the major energy source for organ function in the fetus and neonate. The usual minimum rate of glucose utilisation is 4-8 mg/kg/min. The newborn brain depends upon glucose almost exclusively as a substrate for energy metabolism. The cerebral glucose requirements account for as much as 90% of total glucose consumption. Although alternate fuels, such as ketone bodies, lactate and free fatty acids can be used as a substrate for energy production; the newborn's immature counter-regulatory response limits the availability of these substances, especially in premature or sick infants. Thus, the neonate is susceptible to hypoglycaemia when glucose demands are increased or when exogenous or endogenous glucose supply is limited.

Severe or prolonged hypoglycaemia may result in long-term neurological damage. Transient mild hypoglycaemia in healthy, term newborns does not appear to be harmful to psychomotor development at the age of 4 years.

Hypoglycaemia Definition

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There is no standard, acceptable definition for hypoglycaemia as it is not possible to define a level for a whole population. Each individual will have a different level. We, therefore, use action levels that catch all infants who are hypoglycaemic. This level is <2.6 mmol/L.

Hypoglycaemia Presentation

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Hypoglycaemia in infants can be; Symptomatic (minority) or Asymptomatic (majority).
There are no definitive signs or symptoms that confirm the presence of hypoglycaemia. Clinical features are a guideline for suspecting hypoglycaemia but are not diagnostic of hypoglycaemia.

Clinical features of symptomatic hypoglycaemia may include:

CNS excitation

- Jitteriness, exaggerated Moro reflex
- High-pitched cry
- Irritability
- Seizures (usually implies long standing hypoglycaemia)

CNS depression

- Lethargy
- Apnoea
- Cyanotic spells
- Poor feeding
- Hypotonia, limpness or coma

Due to Catecholamine Response

- Pallor
- Sweating
- Tachycardia

Other Clinical Signs due to Hypoglycaemia

- Bradycardia
- Hypotension
- Heart failure, Cardiac arrest

Risk Factors for Hypoglycaemia in Neonates

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At risk infants are described in the categories below.

Maternal conditions

- Maternal diabetes
- Intrapartum administration of glucose
- Pre-eclampsia
- Maternal drug treatment e.g. terbutaline, propranolol, oral hypoglycaemic agents

Neonatal conditions

- Prematurity (<37 weeks)
- Post-maturity (>42 weeks)
- Low birth weight (<2.5 kg)
- Intrauterine growth restriction (IUGR) and small for gestational age (SGA) (<10th centile)
- Birth weight >4.5 kg or Large for gestational age (LGA) (>90th centile)
  (Note; it is vital to plot all infants on a growth chart to assess SGA or LGA)
- Respiratory distress
- Suspected clinical infection
- Perinatal hypoxia events (with or without good recovery)
- Temperature instability
- Any unwell infant
- Infants with intravenous infusions including parenteral nutrition
- Syndromal abnormalities that can affect glucose, such as Beckwith-Wiedemann syndrome and certain inborn errors of metabolism
- Microphallus, ambiguous genitalia, intracranial abnormalities

Monitoring for Hypoglycaemia

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All infants who have symptoms or risk factors listed above need blood glucose monitoring.

Physiologically, the nadir in blood glucose in newborns takes place at 2 to 3 hours after birth. Hence, this would be an ideal time for screening an asymptomatic “at-risk” newborn. Repeat blood glucose levels may be needed every 3-4 hours before feeds until levels are stable.
Very preterm infants (<34 weeks) and symptomatic newborns need early glucose monitoring, usually within 1-2 hours after birth. The newborns from the postnatal environment or a special care unit (late preterm infants; 34-37 weeks), maternal diabetes) should be tested 3-4 hours after birth, as earlier screening (and treatment) does not seem to improve outcomes but only increases treatment.

Monitoring Frequency

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Initial Screening:

- Very preterm and symptomatic infants; within 1-2 hour of birth
- Late preterm and at risk infants; within 3-4 hours of birth

Ongoing Monitoring:

- Every 3 hours (before every feed) until levels satisfactory and stable
- Then 6–8 hourly until stable for at least 24 hours
- Monitoring often for a minimum of 36-48 hours

Monitoring Period

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At least 24 hours after the last recorded low blood glucose level. Once stable, most preterm and severe IUGR infants admitted to the neonatal unit will require once daily pre-feed blood glucose estimation until 120 mL/kg enteral feeds is reached.

Management: General Recommendations

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- Aim to maintain blood glucose level ≥2.6 mmol/L by keeping infant normothermic and initiating feeds within one hour of birth
- Glucose levels should always be interpreted based on the clinical situation, e.g. a sudden decrease in glucose level, even within the normal range, could still mean action is required
- Always establish early and frequent feeds in infants with risk factors for hypoglycaemia. Check to see if the mother has stored expressed breast milk from antenatal expressing program
- In infants with documented severe hypoglycaemia, calculate glucose intake before and after you make any changes, do not 'estimate'. A usual increased intake is in steps of at least 2 mg/kg/min.
- Normal glucose requirements are 4-6 mg/kg/min for term infants and 6-8 mg/kg/min in preterm infants. Infants with inappropriately high insulin levels will usually require >10 mg/kg/min
- Feeds can be increased in frequency, e.g. from second-hourly to hourly, to correct marginally low blood glucose levels below action levels. (Note; increasing feed frequency does not increase the glucose intake)
- Infants over 32 weeks can usually tolerate feeds at normal volumes (60-80 mL/kg/day) and can be increased up to 100 mL/kg/day if necessary. Over 100 mL/kg/day on day 1 will often result in feed intolerance
- Total fluids over 100 mL/kg/day in the first few days of life may cause fluid overload (including oedema, hyponatraemia, respiratory symptoms etc.) observe carefully if used.
- Infants <32 weeks usually need some IV fluids but may be able to have some of their daily requirement as feed. Over 32 weeks, feeds should be given unless otherwise contraindicated
- Starting IV fluids are glucose 10%. Concentrations over 12.5% are rarely needed and warrant consultation with Fellow or Neonatologist. For dextrose calculations see Appendix 4
- Concentrations above 12.5% require a central line, but do not withhold adequate treatment for severe hypoglycaemia if central access unavailable
- Mothers of infants who require treatment for low blood glucose levels and whose breast milk is not yet available, should be counselled that the benefits of a brief period of formula are considered to outweigh the potential complications of IV access and therapy
- Document management plan in the healthcare record

Management of Hypoglycaemia

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Symptomatic Infants

This is defined in the literature as BGL less than action levels *and* symptoms, *and* symptoms disappear when glucose is given.

One should consider infants with any BGL <2.6 mmol/L and seizures in this definition as well.

Hypoglycaemia Management Table for Very Preterm or Symptomatic Infants (See Appendix 2)

Hypoglycaemia Management Table for Late Preterm or Term Infants (see Appendix 3)

Glucose Intake Calculation

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Formula for Calculating Glucose Intake

$$\text{Glucose intake (mg/kg/min)} = \frac{\%\ \text{glucose} \times \text{volume (mL/kg/day)}}{144}$$

OR

$$\text{Glucose intake (mg/kg/min)} = \frac{\%\ \text{glucose} \times \text{hourly rate}}{\text{Weight (kg)} \times 6}$$

Note; assume term formula or breast milk is 7% and preterm formula 8.5% glucose to calculate intake

Examples of intake in mg/kg/min are in the table below

	Breast milk*	Glucose 10%	Glucose12.5%	Glucose 15%
30 mL/kg	1.5	2.1	2.6	3.1
60 mL/kg	2.9	4.2	5.2	6.3
90 mL/kg	4.4	6.3	7.8	9.4
120 mL/kg	5.9	8.4	10.4	12.5

**Artificial feed has similar glucose content to breast milk*

Diagnostic Tests in Hypoglycaemia

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Unexplained hypoglycaemia for more than 24 hours despite an adequate intake (4-6 mg/kg/min for term infants and 6-8 mg/kg/min in preterm infants) needs further diagnostic evaluation including:

- Insulin levels
- Cortisol levels
- Growth hormone levels
- ACTH levels

Infants with known risk factors for hypoglycaemia due to hyperinsulinaemia (e.g. maternal diabetes) do not usually need further work-up, unless a persistent glucose intake over 12-15 mg/kg/min is required to maintain normoglycaemia.

Persistent Hypoglycaemia: Further Treatment Options

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In persistent hypoglycaemia (>72 hours of more than 12 mg/kg/min intake or over 15 mg/kg/min intake) further treatment options are available. Always discuss with the on service Consultant.

- Diazoxide (2-5 mg/kg every 8 hours) may be used for hyperinsulinaemic conditions. It is usually combined with hydrochlorothiazide (2-4 mg/kg/day in 2 divided doses) to optimise treatment and prevent fluid retention.
- Glucagon bolus IM (200 mcg/kg/dose) or infusion (10-20 mcg/kg/hr) is effective if an acute response is needed, e.g. if IV access is delayed in the presence of significant hypoglycaemia.
- Hydrocortisone IV/oral (1 mg/kg/dose, 3 doses a day) for cortisol deficiency conditions. The actions are to stimulate the liver to form glucose from amino acids & glycerol and stimulate the deposition of glucose as glycogen. There is also diminished peripheral glucose utilisation.

- Octreotide subcutaneous or IV injection (1 mcg/kg/dose, every six hours, titrate upwards until effect, max 10 mcg/kg/dose every six hours) can be used if the hypoglycaemia is resistant to diazoxide. Most effective in congenital hyperinsulinaemia.
- If all else fails, full diagnostic work-up and possible surgical management should be considered.

IMPLEMENTATION PLAN

The clinical guideline will be:

- Circulated to Head of Department and Managers in NICU
- Circulated to the clinicians via the Children Young People and Families Network and the Women's Health and Maternity Network (where applicable)
- Made available on the intranet (PPG) and HNEKids website
- Presented at facility/unit meetings and tabled for staff to action

MONITORING AND AUDITING PLAN

- The person or leadership team approving the clinical guideline is responsible for ensuring timely and effective review of the guideline.
- Evaluation will require a review of the most current evidence as well as consideration of the experience of Neonatal staff at JHCH in the implementation of the clinical guideline.
- Data derived from monitoring and evaluation should inform the review of the clinical guideline either as required or scheduled.
- Implementation, education support and monitoring compliance be completed by local Clinical Educators and Unit Managers.
- Amendments to the guideline will be ratified by the Clinical Director and Manager of Newborn Services prior to final sign off by the JHCH.

CONSULTATION WITH KEY STAKEHOLDERS

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APPENDICES

1. Glossary & Abbreviations
2. Hypoglycaemia Management Table for Very Preterm or Symptomatic Infants
3. Hypoglycaemia Management Table for Late Preterm or Term Infants
4. Making Non-Standard Glucose Fluids in NICU

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FEEDBACK

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

APPENDIX 1

GLOSSARY & ABBREVIATIONS

Acronym or Term	Definition
ACTH	Adrenocorticotropic Hormone
BGL	Blood Glucose Level
CYPFS	Children, Young People and Families Services
IM	Intramuscular
IUGR	Intrauterine Growth Restriction
IV	Intravenous
JHCH	John Hunter Children's Hospital
LGA	Large for Gestational Age
NICU	Neonatal Intensive Care Unit
SCU	Special Care Unit
SGA	Small for Gestational Age
mcg/kg/dose	Microgram per kilogram per dose
mcg/kg/hr	Microgram per kilogram per hour
mg/kg	Milligram per kilogram
mg/kg/min	Milligram per kilogram per minute

APPENDIX 2

HYPOGLYCAEMIA MANAGEMENT TABLE FOR VERY PRETERM OR SYMPTOMATIC INFANTS

BGL ≤1.6 mmol/L or Symptomatic Hypoglycaemia <2.6mmol/L	**BGL between 1.7 mmol/L and 2.5 mmol/L**	**BGL ≥2.6 mmol/L**
Severe or Symptomatic Hypoglycaemia	***Hypoglycaemia***	***Normoglycaemia***
1. If not on IV fluids, initiate intravenous glucose at a minimum intake of 4 mg/kg/min (term) or 6 mg/kg/min (preterm) *Do not rely on oral or intra-gastric feeding to correct severe or symptomatic hypoglycaemia* 2. Give a bolus of glucose 200 mg/kg (2 mL/kg) of glucose 10% over 10 minutes 3. If already on feeds or IV fluids, increase the intake by at least 2 mg/kg/min with a minimum of 4 mg/kg/min (term) or 6 mg/kg/min (preterm) after the bolus is given 4. Recheck blood glucose concentration 30 minutes after intervention is completed or 1 hour after last glucose *(ideally, this should be the same time)*	1. Increase the current intake by at least 2 mg/kg/min 2. Ensure a minimum intake of 4 mg/kg/min (term) or 6 mg/kg/min (preterm). Depending on gestational age or severity of risk factors, this can be oral or IV. Oral feeds may be increased in frequency e.g. from 2-hourly to hourly, *note this does not increase the intake* 3. Recheck blood glucose concentration before subsequent feeds until the value is acceptable (≥2.6 mmol/L) and stable	1. Evaluate any normal glucose level in the context of earlier glucose levels; look at the trend

APPENDIX 3

HYPOGLYCAEMIA MANAGEMENT TABLE FOR LATE PRETERM OR TERM INFANTS

BGL ≤1.6 mmol/L or Symptomatic Hypoglycaemia <2.6mmol/L	**BGL between 1.7 mmol/L and 2.5 mmol/L**	**BGL ≥2.6 mmol/L**
Severe or Symptomatic Hypoglycaemia	***Hypoglycaemia***	***Normoglycaemia***
1. Consult with Neonatal Medical team 2. Immediately complement feed with 10 mL/kg of expressed breast milk or artificial feed 3. Arrange for an immediate formal BGL (if not already complete) 4. Check temperature and assess infant for symptoms 5. Skin to skin contact while arranging a formal BGL (where applicable) 6. All symptomatic infants will need IV therapy, and most asymptomatic infants with severe hypoglycaemia will need IV therapy	1. Complement feed with 10 mL/kg of Expressed Breast Milk or Artificial Feed 2. Check temperature and assess infant for symptoms 3. Recheck blood glucose concentration before subsequent feeds until the value is acceptable (≥2.6 mmol/L) and stable for at least 3 readings 4. Consult with Neonatal Medical team if second BGL is <2.6 mmol/l 5. Monitor the infants feeding regime and record plan in infants healthcare record	1. Establish early and frequent breast feedings and offer skin to skin contact (where applicable) 2. Artificially fed infants offer next feeds at 60 mL/kg/day 3. Recheck blood glucose concentration before subsequent feeds until the value is acceptable (≥2.6 mmol/L) and stable for at least 3 measurements 6. Monitor the infants feeding regime and record plan in infants healthcare record 4. Always evaluate any normal glucose level in the context of earlier glucose levels (look at the trend)

APPENDIX 4

MAKING NON-STANDARD GLUCOSE FLUIDS IN NICU

Making Non-Standard Glucose fluids in NICU		
To make Glucose 12.5%		
Use a bag of Glucose 10%, 500 mL REMOVE 31 ML	**ADD** Glucose 50%, 31 mL	Final concentration: Glucose 12.5%, 500mL
To make Glucose 15%		
Use a bag of Glucose 10%, 500 mL REMOVE 62.5 ML	**ADD** Glucose 50%, 62.5 mL	Final concentration: Glucose 15%, 500 mL
To make Glucose 17.5%		
Use a bag of Glucose 10%, 500 mL REMOVE 94 ML	ADD Glucose 50%, 94 mL	Final concentration: Glucose 17.5%, 500 mL
To make Glucose 20%		
Use a bag of Glucose 10%, 500 mL REMOVE 125 ML	ADD Glucose 50%, 125 mL	Final concentration: Glucose 20%, 500 mL

Reference: Medcalc: Dextrose Converter