Procedure

Hypoglycaemia, unexplained: Management of the paediatric patient who presents to Emergency

Metabolic Medicine

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Executive sponsor	Executive Director Medical Services			**Effective date**	19/05/2016
Author/custodian	Metabolic Nurse Practitioner			**Review date**	19/05/2019
Supercedes	1.0				
Applicable to	All Children's Health Queensland Hospital and Health Service Staff				
Authorisation	Executive Director Hospital Services				

Purpose

This procedure provides an evidenced-based guideline for the management of a child who presents to an emergency department with unexplained hypoglycaemia.

Maintaining glucose homeostasis relies on;

- An intact system of endocrine hormones (insulin, glucagon, growth hormone, cortisol)
- A system of intact metabolic pathways to be able to use fat, protein and glucose
- Suitable substrates that are able to metabolised to produce glucose / ketones for energy in times of fasting (e.g. glycogen, protein, fat)

Scope

This procedure provides medical and nursing staff with management strategies for children presenting with hypoglycaemia to the Lady Cilento Children's Hospital. It includes management in the Department of Emergency Medicine (DEM) to a ward setting as well as discharge planning.

For treatment of children with hypoglycaemia at other Queensland Health hospitals, a customised protocol / procedure specific to the local site should be developed in conjunction with the local paediatric medical officer.

Procedure

This procedure outlines the roles and responsibilities of the medical officer and registered nurse caring for a child with hypoglycaemia at LCCH.

1.1 Definition of Hypoglycaemia

Hypoglycaemia is defined as a blood glucose measurement of **equal to or lower than 2.6 mmol/L** using an arterial blood gas (ABG) machine, iSTAT, or formal laboratory testing.

1.2 History / Examination

Any child may become hypoglycaemic as a result of prolonged fasting or a severe vomiting or diarrhoea illness. Some children become symptomatic of hypoglycaemia or hypoglycaemic faster than others.

It is important to document a full history and examination to discover other precipitating causes that need further investigation or evaluation.

Key questions on the history include:

- How long has the child fasted before becoming hypoglycaemic?
- Has the child suffered symptoms of vomiting, diarrhoea or fasted in the last 3 days?
- Is the child sometimes difficult to wake in the morning?
- How long do they usually fast overnight?
- Was the hypoglycaemia precipitated by a protein meal?
- Has the child had recent exposure to fruit or honey (think about hereditary fructose intolerance)?
- Has the child had access to any medications or drugs (e.g. Parents / grandparents' medications, especially insulin, metformin, beta-blockers, alcohol etc.)?

Clues on examination that may indicate a need for further evaluation and investigation of hypoglycaemia include:

- Midline defects – think about the possibility of pituitary hormone deficiencies
- Organomegaly – think about storage disorders (e.g. glycogen storage disease)
- Small genitalia in a male child – think about possibility of pituitary hormone deficiencies
- Hyperpigmentation – think about possibility of adrenal insufficiency
- Short Stature
- Macrosomia
- Growth hormone deficiency or overgrowth syndrome
- Hyperinsulinism – especially in an infant

1.3 Acute Management

ALERT:
Hypoglycaemia is a MEDICAL EMERGENCY
If left untreated it can cause convulsions, irreversible brain damage and death

Intravenous access should be obtained rapidly if:

- Blood Glucose Level (BGL) recorded on a glucometer is **less than 3.0mmol/L**
  (Glucometers do not provide accurate levels at the low end of the scale and should be used as a guide only – refer to the glucometer user manual)

OR

- BGL recorded on a formal laboratory testing or iSTAT machine is **2.6mmol/L or below**

Upon obtaining intravenous (IV) access:

- **Confirm hypoglycaemia** on an iSTAT machine or formal blood glucose sample
- **Draw 6mL of blood for further investigations** (See **Section 3.4 Investigations** below)
- **Measure blood ketones** using a blood ketone monitor
- **Treat hypoglycaemia** with an initial intravenous bolus of **2 mL/kg of 10% glucose**
- After the IV bolus, commence an infusion of **10% glucose with 0.9% NaCl** at maintenance rate
- **If the child is dehydrated,** commence maintenance fluids **plus replacement of deficit over 24 hours**

ALERT:

Intravenous Recipes

10% Glucose with 0.9% NaCl

Take a 1L bag of 5% Glucose with 0.9% Sodium Chloride, withdraw 100mL of fluid from the bag and discard. Inject 100mL of 50% glucose into the bag. Mix well.

Strict observation of IV site must be followed looking for signs of extravasation as a result of the hyperosmolality of the infusion - as per CHQ-PROC-03450: Intravascular Access Device, Management (Peripheral and Central Venous Access Devices)

All patients with hypoglycaemia of unknown cause require admission. Ketotic hypoglycaemia is the most common cause of hypoglycaemia in childhood but should **only** be diagnosed once other possible causes are excluded. **Ketotic hypoglycaemia is a variant of normal.**

ALERT:

Is hypoglycaemia in this child the primary problem?
Could it be related to other causes?

- Infection causing vomiting
- Liver disease
- Hyperinsulinism
- Hormone deficiencies
- Neonatal sepsis
- Metabolic cause
- Ingestions in younger children
- Drugs / Alcohol in an adolescent

1.4 Investigations

Knowledge of the presence of ketones in urine +/- blood at time of presentation is essential to differentiating possible causes of the hypoglycaemia and final diagnosis.

Collect blood and urine as per table below: (other bloods should be collected as clinically indicated)

PREFERRED Initial Investigations for Unexplained Hypoglycaemia (minimum volume 5.5mL required)

Tube Type	Tube Description	Minimum Volume	Tests Required
Serum	**RED pedi-pot** 	**3 mL**	**acylcarnitine profile cortisol growth hormone insulin E/LFTs beta hydroxybutyrate**
Fluoro-oxalate	**GREY** 	**1 mL**	**Glucose lactate**
EDTA Notify and Send to lab urgently	**PURPLE pedi-pot** 	**0.5 mL**	**ammonium**
Lithium heparin	**GREEN pedi-pot** 	**0.5 mL**	**plasma amino acids**
Pyruvate	**Tubes held in DEM fridge or available from Pathology at LCCH**	**0.5 mL**	**pyruvate**

In case of difficulty collecting the preferred volume of blood, the required tests are listed below in order of priority according to age:

NEWBORN or less than six (6) months (In order of importance)

1st Priority investigations (minimum blood sample – 2mL)

Tube Type	Tube Description	Minimum Volume	Tests Required
Fluoro-oxalate	GREY 	1 mL	Glucose lactate
Serum	RED pedi-pot 	0.5 mL	cortisol insulin
Lithium heparin	GREEN pedi-pot 	0.5 mL Could be done from a newborn screening card is sample collection is difficult	acylcarnitine profile

2nd priority investigations (minimum blood sample – 3.5 mL)

Tube Type	Tube Description	Minimum Volume	Tests Required
Serum	RED pedi-pot 	0.5 mL	Growth hormone
Lithium heparin	GREEN pedi-pot 	0.5 mL	Plasma amino acids
EDTA Notify and Send to lab urgently	PURPLE pedi-pot 	0.5 mL	Ammonium Send to lab urgently Notify lab to expect sample
Serum	RED pedi-pot 	1.0 mL	E/LFT
Pyruvate	Tubes held in DEM fridge or available from Pathology at	0.5 mL	pyruvate

	LCCH		
Serum	**RED pedi-pot** 	**3 mL**	**beta hydroxybutyrate**

Greater than six (6) months:-
1st Priority investigations (minimum blood sample – 2mL)

Tube Type	Tube Description	Minimum Volume	Tests Required
Fluoro-oxalate	**GREY** 	**1 mL**	**Glucose lactate**
Serum	**RED pedi-pot** 	**0.5 mL**	**cortisol insulin**
Lithium heparin	**GREEN pedi-pot** 	**0.5 mL Could be done from a newborn screening card is sample collection is difficult**	**acylcarnitine profile**

2nd priority investigations (minimum blood sample – 4.0mL)

Tube Type	Tube Description	Minimum Volume	Tests Required
EDTA Notify and Send to lab urgently	**PURPLE pedi-pot** 	**0.5 mL**	**Ammonium**
Serum	**RED pedi-pot** 	**0.5 mL**	**Growth hormone**
Pyruvate	**Tubes held in DEM fridge or available from Pathology at LCCH or call blood collectors 4542**	**0.5 mL**	**pyruvate**

Serum	**RED pedi-pot** 	**1.0 mL**	**E/LFT**
Lithium heparin	**GREEN pedi-pot** 	**0.5 mL**	**Plasma amino acids**
Serum	**RED pedi-pot** 	**0.5 mL**	**beta hydroxybutyrate**

Label samples (blood and urine) with time and date.

Collect Urine Sample and send to the laboratory for measurement of for a urine metabolic screen (this includes urine amino acids and organic acids)

ALERT:

Critical Urine Sample:

The first urine passed after the episode of hypoglycaemia (BGL equal to or lower than 2.6mmol/L) is the CRITICAL SAMPLE and must be collected and sent for a urine metabolic screen regardless of age (i.e. Even if it is passed sometime after the episode).

Nursing staff should test urine for ketones after 24 hours of treatment to ensure urine ketones have cleared or are clearing. Ketones alone can make people feel nauseated and this may not settle until the ketones have cleared.

1.5 Admission and Monitoring and Management

Children admitted with hypoglycaemia require routine clinical observation. Regular monitoring of blood glucose levels is **NOT** generally indicated unless:

- There is inappropriate insulin in response to hypoglycaemia
- The chid is demonstrating symptoms that are of clinical concern i.e. pallor, vomiting, tachycardia, drowsiness
- Ketones are absent or inappropriately low. In these cases, hyperinsulinism should be considered and blood glucose monitoring should continue until insulin level is known
  - If there is significant ketosis and there is a dextrose infusion or a carbohydrate naso-gastric feed running there is no need to monitor BGLs because there is minimal risk of hypoglycaemia while dextrose therapy is patent and running
  - *__NOTE:__ Children with hyperinsulism or glycogen storage disease will have a fasting tolerance of 3 – 6 hours

MONITORING in the Emergency Department

- Baseline observations – temperature, pulse, oximetry, blood pressure, blood glucose and blood ketones

MONITORING once admitted to Ward

- Ward test urine for urinary ketones every 12 to 24 hours
  - BGL monitoring if documented to be clinically indicated by the Medical Officer
  - Hourly IV site checks

It is the treating / admitting doctor's responsibility to document if BGL monitoring is medically indicated.

ALERT:

Subspecialty teams (e.g. endocrine, gastroenterology or metabolic) should be consulted as clinically indicated by the results of the hypoglycaemic screen so that appropriate management strategies or investigations may be implemented.

1.6 Management on the Ward

MONITORING once admitted to Ward

- **Ward test urine for urinary ketones every 12 – 24 hours**
- **Hourly IV site checks**
- **BGL monitoring ONLY if documented to be clinically indicated by the consultant/fellow (See below)**
- Continue 10% glucose with 0.9% sodium chloride solution at maintenance rate. Prescribe additional fluids to replace deficit if dehydrated **(5% glucose infusion is usually not sufficient to maintain BGL or clear ketones)**
- Once 10% glucose with 0.9% sodium chloride solution is running and patent, the child is at minimal risk of hypoglycaemia and **DOES NOT REQUIRE BGL MONITORING** unless there is a clinical indication. This should be discussed with the consultant /fellow from the treating team
- If significant symptoms of nausea or vomiting are present, Ondansetron may be prescribed (if over 12 months of age)
- Encourage oral diet (food has far more calories than intravenous glucose)
- **Nursing staff should test urine for ketones after 12 - 24 hours of treatment to ensure urine ketones are clearing.** Ketones alone can make people feel nauseated and this may not settle until the ketones have cleared
- Once tolerating oral intake, IV fluids may be discontinued or changed to 5% glucose with 0.9% NaCl at a reduced rate
- Organise discharge medications early in the admission – Ondansetron, Glucose Gel and Polyjoule (less than 12 months of age) / CarbPlus (Greater that one (1) year of age) **(Individual Patient approval is required for Ondansetron and Glucose Gel – non LAM indications)**

ALERT:

If an overnight fast precipitated the hypoglycaemic event, early referral to the metabolic team is advisable for advice regarding need for administration of night time cornstarch

1.7 Discharge Planning

Discharge script should include:

- 1 tube of glucose gel and ondansetron (will need Individual Patient Approval)
- +/- 1 can of Polyjoule (less than 12months of age) / Carb Plus (Greater that one (1) year of age) with the age-appropriate recipe or discussion with parents / guardians to source Lucozade as an appropriate alternative to glucose polymer for children over the age of 5 years.

A child diagnosed with symptomatic hypoglycaemia requires a follow up appointment to ensure that there is no other cause for their episode. Some investigation results will not be available at the time of discharge. These should be reviewed at the follow up visit in the Outpatient Department.

If 1st admission of hypoglycaemia with unknown cause:

Formal written referral to Department of Metabolic Medicine for an outpatient review to review hypoglycaemia screen.

Subsequent admissions:

Liaise with metabolic team to determine need for further outpatient follow up, if needed book into admitting General Paediatric outpatient clinic.

Prior to discharge:

- Educate Parent / Guardians on the signs and symptoms of hypoglycaemia and emergency management of hypoglycaemia
- Give Parent / Guardians written instructions on sick day management to prevent a recurrent episode of hypoglycaemia (less than 12 months of age seek Dietitian review for advice on sick day planning)

SICK DAY PLANS

For children aged between 12 months – 4 years of age

Unwell Regimen – 10% Carbohydrate Solution

- To be initiated at the first signs of illness – normal diet to be temporarily discontinued
- Provide unwell regimen in small, frequent feeds, keeping an accurate record of how much is consumed
- Contact your Doctor immediately if your child is on an unwell regimen

To make up solution, warm the specified amount of water and dissolve the recommended amount of Polyjoule or CarbPlus in it. Mix well and store in the fridge.

Beverage	Recipe
• Polyjoule • (8g scoop)	1 ¼ scoops (10.5g) of Polyjoule in 100mL water
Polyjoule+ Ribena	5 teaspoon Ribena syrup + 1 scoop (8g) Polyjoule in 100mL water
Polyjoule + Cordial	3 teaspoons Cordial syrup + 1 scoop (8g) Polyjoule in 100mL water *Use regular cordial (not diet)

Beverage	Recipe

• CarbPlus • (10g scoop)	1 heaped scoop (11g) CarbPlus in 100mL water
CarbPlus + Ribena	1 teaspoon Ribena syrup + 1 level scoop (10g) of CarbPlus in 100mL water
CarbPlus + Cordial	1 teaspoon Cordial syrup + 1 level scoop (10g) of CarbPlus in 100mL water *Use regular cordial (not diet)

*Please use the scoop provided with the product for accurate dosing.

For children aged between 5 – 12 years of age (primary school age children)

- Unwell Regimen – 15% Carbohydrate Solution

- To be initiated at the first signs of illness – normal diet to be temporarily discontinued.
- Provide unwell regimen in small, frequent feeds, keeping an accurate record of how much is consumed.
- Contact your Doctor immediately if your child is on an unwell regimen

To make up solution, warm the specified amount of water and dissolve the recommended amount of Poly-Joule / CarbPlus in it. Mix well and store in the fridge.

Beverage	Recipe
• Polyjoule • (8g scoop)	2 level scoops (16g) Polyjoule in 100mL water
Polyjoule + Ribena	1 ¾ level scoops (14g) Polyjoule + 4 teaspoons Ribena syrup in 100mL water
Polyjoule + Cordial	1 ½ level scoops (11.25g) Polyjoule + 4 teaspoons Cordial syrup in 100mL water *Use regular cordial (not diet)
Polyjoule + Fruit Juice	1 level scoop (8g) Polyjoule in 100mL fruit juice

Beverage	Recipe
• CarbPlus • (10g scoop)	1 ¾ level scoops (17.5g) CarbPlus in 100mL water
CarbPlus + Ribena	1 ½ level scoops (15g) CarbPlus + 2 teaspoons Ribena in 100mL water
CarbPlus + Cordial	1 ¼ level scoops (12.5g) CarbPlus + 4 teaspoons Cordial *Use regular cordial (not diet)
CarbPlus + Fruit Juice	¾ level scoops (7.5g) CarbPlus + 100mL fruit juice ■

Beverage	Recipe
Lucozade Energy	Ready to drink 18% solution

*Please use the scoop provided with the product for accurate dosing.

For children aged 12 years of age and older (secondary school age children)

- Unwell Regimen – 20% Carbohydrate Solution

- To be initiated at the first signed of illness – normal diet to be temporarily discontinued.

- Provide unwell regimen in small, frequent feeds, keeping an accurate record of how much is consumed.
- Contact your Doctor immediately if your child is on an unwell regimen

To make up solution, warm the specified amount of water and dissolve the recommended amount of Poly Joule / CarbPlus in it. Mix well and store in the fridge.

Beverage	Recipe
• Polyjoule • (8g scoop)	2 ¾ level scoops (22g) Polyjoule in 100mL water
• Ribena	2 ½ level scoops (20g) Polyjoule + 2 teaspoons Ribena syrup in 100mL water
• Cordial	2 ¼ level scoops (18g) Polyjoule + 4 teaspoons Cordial syrup in 100mL water *Use regular cordial (not diet)
• Fruit juice	1 ¼ level scoops (10g) Polyjoule in 100mL fruit juice

Beverage	Recipe
• CarbPlus • (10g scoop)	2 ¼ level scoops (25g) CarbPlus in 100mL water
CarbPlus + Ribena	2 level scoops (20g) CarbPlus + 4 teaspoons Ribena syrup in 100mL water
CarbPlus + Cordial	1 ¾ level scoops (17.5g) CarbPlus + 5 teaspoons Cordial syrup in 100mL water *Use regular cordial (not diet)
CarbPlus + Fruit juice	1 ¼ level scoops (12.5g) CarbPlus in 100mL fruit juice

*Please use the scoop provided with the product for accurate dosing

Beverage	Recipe
Lucozade Energy	Ready to drink 18% solution

Food Alternatives

Food	Amount
Sugar	4 rounded teaspoons
Boiled lollies / barley sugars	4 to 5 lollies
Jelly beans / jelly babies / jube lollies	7 lollies
Lifesavers	8½ lifesavers

The family should be educated that if the child has two (2) episodes of vomiting at home then ondansetron should be given and if vomiting persists, instruct the family to present to the emergency department for evaluation.

- If the family does not have ondansetron at home, they should present to the emergency department for evaluation after two episodes of vomiting or if not tolerating any oral intake

ALERT:

We **DO NOT** recommend families purchase glucometers or monitor blood glucose levels at home because glucometers are known to be inaccurate at low levels. We want to avoid parents being falsely reassured or alarmed by a number on a monitor. Reinforce that if the child is symptomatic, the child needs to be treated.

Medico-legal Documentation Requirements

The Medical Officer will document:

- Clinical history
- Clinical examination
- Investigations
- Clinical admission plan (including BGL monitoring if and why indicated)
- Discharge planning and education provided to parents in the medical record

The Registered Nurse will document:

- Fluid balance record
- Monitoring of urinary ketones
- Medical record
- Nursing care plan
- Observations on age-appropriate CEWT chart
- Hourly IV site patency checks
- Discharge planning and education provided to parent/guardian

Consultation

Key stakeholders who reviewed this version:

- Director, Metabolic Physician, Department of Metabolic Medicine, CHQ.
- Metabolic Physicians, Department of Metabolic Medicine, CHQ.
- Metabolic Nurse Practitioner, Department of Metabolic Medicine, CHQ
- Department of Emergency Department medical and nursing staff
- Paediatric Intensive Care Unit
- Department of General Paediatrics, CHQ
- Food and Dietetics Department, CHQ
- Endocrinologists, Department of Endocrinology and Diabetes, CHQ

Definition of terms

Term	Definition	Source

Hypoglycaemia	A blood glucose measurement of **equal to or lower than 2.6 mmol/L** using an arterial blood gas (ABG) machine, iSTAT, or formal laboratory testing	See references listed below

References

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Audit/evaluation strategy

Level of risk	High
Strategy	• Completeness of pathology testing panel • Observations • Adverse event management • Clinical incidents reported as per CHQ-Proc-00200 Clinical Incident Management
Audit/review tool(s) attached	Nil
Audit/Review date	Quarterly Snapshot Audit
Review responsibility	Metabolic Clinical Nurse Consultant/Nurse Practitioner
Key elements / Indicators / Outcomes	• Number and % of adverse events/ clinical incidents relating to the management of children with Hypoglycaemia • Management outcomes of adverse events relating management of children who present with Hypoglycaemia

Procedure revision and approval history

Version No.	Modified by	Amendments authorised by	Approved by
1.0	RN Metabolic Medicine CNC Metabolic Medicine	Director,Metabolic Medicine Drugs and Therapeutics Committee	General Manager Operations
2.0	NP Metabolic Medicine	Divisional Director, Medicine	Executive Director Hospital Services

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