Scope
This guideline is aimed at all Health Care Professionals involved in the care of infants within the Perinatal Directorate.

This guideline has been updated in 2018 to meet the British Association of Perinatal Medicine (BAPM) framework for practice; ‘Identification and management of neonatal hypoglycaemia in the full term infant – A framework for practice’ October 2017 [1].

Aims
• To minimise inappropriate blood taking of term infants and
• To detect significant or symptomatic hypoglycaemia in infants at risk, AND to maximise:
  • Appropriate investigation and management of severe or symptomatic hypoglycaemia

Key Links:
Table 2: Infants who require blood glucose (BG) monitoring
Table 3: Birthweight on 2nd centile
Table 5: Investigations for neonatal hypoglycaemia (blood bottles and urine tests)

Flowcharts for the Management of the Healthy Term Infant ≥ 37 weeks
(Delivery Suite and Postnatal Wards)
Flowchart A. Management of term infants ≥ 37 weeks at risk of hypoglycaemia
Flowchart B. Prefeed blood glucose 1 – 1.9 mmol/l and no abnormal clinical signs
Flowchart C. Blood glucose < 1mmol/l and / or clinical signs consistent with hypoglycaemia
Flowchart D. Management of Reluctant Feeding in healthy term infants ≥ 37 weeks

Flowcharts for the Management of the Preterm Infant ≤ 37 weeks
Management of preterm infants (<37 weeks) with hypoglycaemia

Flowcharts for the Management of neonates on the Neonatal Unit
Flowchart E. Management of Hypoglycaemia on the Neonatal Unit

Appendices
Appendix 1: Use of dextrose gel (dose and administration)
Appendix 2: Parent information
1 Key Points – Glucose Monitoring

- **Do not** routinely monitor Blood Glucose (BG) in healthy appropriately grown term infants [2]

- Most healthy term neonates **do not** develop “symptomatic hypoglycaemia” as a consequence of underfeeding [3]

- Infants at risk of impaired metabolic adaptation and hypoglycaemia should be identified at birth and placed on a care pathway that includes early provision of energy, regular assessment of feeding and clinical condition and **pre-feed** BG monitoring - aim to maintain BG ≥ 2.0mmol/l [1]

- Infants at risk of impaired metabolic adaptation and hypoglycaemia include infants of diabetic mothers, infants whose mothers have taken beta-blockers, large for gestational age infants (birthweight > 4.5kg), infants with intrauterine growth restriction (IUGR – birthweight < 2nd centile) and preterm infants.

**Key Points – Treatment of Hypoglycaemia**

- Urgent medical review and intervention for infants with:
  - A BG value <1.0mmol/l at any time
  - A single BG value <2.6mmol/l in a neonate with abnormal clinical signs
  - A BG value <2.0mmol/l and remaining <2.0mmol/l at next measurement in a baby with a risk factor for impaired metabolic adaptation and hypoglycaemia but without abnormal clinical signs.

- Buccal dextrose gel may be used in conjunction with a feeding plan when the blood glucose is <2.0mmol/l.

- Severe (BG < 1.0mmol/l) or persistent hypoglycaemia (three or more measurements < 2.0 mmol/l in first 48 hours after birth) requires urgent medical review, investigation and intervention.

- Parents are partners in the care of infants at risk of impaired metabolic adaptation and hypoglycaemia. Parents should be given verbal and written information that describes why their baby is receiving extra support and BG monitoring; how to reduce the likelihood of hypoglycaemia; the signs that indicate when a baby is becoming unwell; and how to raise concerns about their baby’s well-being or feeding pattern.
2 Background

Transient hypoglycaemia occurs as a normal physiological event following delivery but persistent significant hypoglycaemia can result in brain injury and long-term neurodevelopmental impairment. Persistent significant hypoglycaemia can result in damage to the occipital lobes and consequent cortical blindness [7, 8]. Middle cerebral artery infarction and basal ganglia/thalamic abnormalities have also been described [9].

Hypoglycaemia is the leading cause of admission of term infants to neonatal units in England. However, studies have shown that in over 50% of the admissions the BG value was ≥ 2.0mmol/l [1]. This results in unnecessary separation of mother and baby.

There is great variation amongst neonatal units in the definition of hypoglycaemia and thresholds for intervention. To promote safer practices and avoid unnecessary intervention and separation of mother and baby, NHS Improvement and British Association of Perinatal Medicine (BAPM) developed an evidence based Framework for Practice (FfP) [1] to address variation in practices in the identification, management and admission thresholds of term babies admitted to neonatal units for hypoglycaemia and to promote safer practices that avoid unnecessary separation of mother and baby. The UHL guideline has been updated in 2018 to meet this national guidance.

The exact definition of clinically important hypoglycaemia has long been debated[10]

**Normal blood sugar levels**
A BG level ≥ 2.6mmol/l and showing no signs of hypoglycaemia is generally accepted as normal

In well term infants (≥ 37 weeks) and late preterm infants (34-36 weeks) cared for on the postnatal ward, a target of ≥ 2.0mmol/l is acceptable.

In unwell term and preterm infants admitted to the neonatal unit, aim for BG ≥ 2.6mmols/l.

**Significant Hypoglycaemia**
A BG level < 1.0mmol/l is **always** considered significant [4]
3 Causes of hypoglycaemia in newborn

Table 1: Causes of hypoglycaemia in newborn

<table>
<thead>
<tr>
<th>Poor glucose stores/production</th>
<th>Increased glucose demand</th>
<th>Hyperinsulinaemia</th>
<th>Not enough anti-insulin hormones</th>
</tr>
</thead>
<tbody>
<tr>
<td>IUGR infants</td>
<td>Hypothermia</td>
<td>Infant of diabetic mother</td>
<td>Pituitary insufficiency</td>
</tr>
<tr>
<td>Preterm infants</td>
<td>Severe rhesus disease</td>
<td>Islet cell disorders</td>
<td>Adrenocortical deficiency</td>
</tr>
<tr>
<td>Fluid restricted infants</td>
<td>Septicaemia</td>
<td>Maternal drugs: beta blocker e.g. labetalol</td>
<td></td>
</tr>
<tr>
<td>Moderate – Severe birth asphyxia</td>
<td>Respiratory distress</td>
<td>Beckwith Wiedemann syndrome</td>
<td></td>
</tr>
<tr>
<td>Inborn errors of metabolism (IEM)</td>
<td>Seizures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Midline defects</td>
<td>Polycythaemia</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Infants who require BG monitoring

- Preterm infants (< 37 weeks)
- Intrauterine growth restriction (birthweight < 2nd centile)
- Infants of diabetic mothers (Type I & II Diabetes and Gestational Diabetes Mellitus)
- Maternal drugs: beta-blockers e.g. labetalol in third trimester or at the time of delivery
- Large for gestational age (birthweight > 4.5kg)

Table 3: Birthweight on 2nd centile

<table>
<thead>
<tr>
<th>Gestational age / weeks</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
<td>2.10</td>
<td>2.00</td>
</tr>
<tr>
<td>37 + 4</td>
<td>2.20</td>
<td>2.10</td>
</tr>
<tr>
<td>38</td>
<td>2.30</td>
<td>2.20</td>
</tr>
<tr>
<td>38 + 4</td>
<td>2.40</td>
<td>2.30</td>
</tr>
<tr>
<td>39</td>
<td>2.50</td>
<td>2.45</td>
</tr>
<tr>
<td>40</td>
<td>2.65</td>
<td>2.60</td>
</tr>
<tr>
<td>41</td>
<td>2.80</td>
<td>2.75</td>
</tr>
<tr>
<td>42</td>
<td>2.90</td>
<td>2.85</td>
</tr>
</tbody>
</table>

In addition to the above list, consider BG in infants with any of the following diagnoses:
- Symptoms of hypoglycaemia (see below)
- Perinatal stress such as hypoxic-ischaemia. Perinatal acidosis (cord arterial or infant pH <7.1 and base deficit ≥ -12mmol/l)
- Respiratory distress
- Meconium aspiration syndrome
- Hypothermia (<36.5 C) (independent significant risk factor)
- Suspected / confirmed early onset sepsis
- Symptomatic polycythaemia
1 Symptoms of Hypoglycaemia

Infants may manifest neuroglycopenic signs and symptoms when BG level is low. These can be subtle and are often non-specific. As these infants are at risk of poor neurological outcome, it is vital that such signs/symptoms are treated. If truly caused by hypoglycaemia, such signs are relatively easily and quickly reversed by normalisation of BG levels.

Symptoms of hypoglycaemia:
- Altered level of consciousness: Coma, lethargy, hypotonia, stupor, irritability
- Hypothermia
- Apnoea,
- High pitched cry
- Cyanosis, pallor
- Abnormal feeding behaviour after previously feeding well
- Seizures, tremor and jitteriness
  (jitteriness - excessive repetitive movements of one or more limbs, which is unprovoked and not in response to a stimulus)

Abnormal feeding behaviour (not waking for feeds, not sucking effectively, appearing unsettled and demanding very frequent feeds), especially after a period of feeding well may be indicative of hypoglycaemia. It should prompt a full clinical assessment and consideration of BG measurement.

2 Measurement of blood glucose in the newborn

Accurate measurement of blood glucose level is essential for diagnosis and management of neonatal hypoglycaemia.

As recommended by BAPM [1], ward-based blood gas machine should be used for measuring blood glucose as they will produce more accurate and quick BG results that correlate with laboratory plasma glucose results in the majority of cases.

If handheld glucometers are being used to screen for low BG, only those devices conforming to the ISO15197:2013 standard should be used and their limitations should be understood: possible error of +/-0.8mmol/l for values < 5.5mmol/l. All current cot side technologies are prone to some inaccuracy, particularly in the range 0 - 2.0mmol/l. If a BG result < 2.0mmols/l is obtained using a handheld glucometer, recheck the result immediately using blood gas machine or the laboratory BG provided baby’s clinical condition allows this. Do not delay treatment for hypoglycaemia while awaiting laboratory BG results.
3 Management of term infants (≥ 37 weeks) with hypoglycaemia

<table>
<thead>
<tr>
<th>Term Infants at risk of hypoglycaemia</th>
<th>Flowchart A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term Infants with a pre feed blood sugar 1-1.9 and asymptomatic</td>
<td>Flowchart B</td>
</tr>
<tr>
<td>Term Infants with a blood sugar &lt;1 and/or clinical signs of hypoglycaemia</td>
<td>Flowchart C</td>
</tr>
<tr>
<td>Supporting term infants reluctant to feed</td>
<td>Flowchart D</td>
</tr>
</tbody>
</table>

3.1 Delivery suite/Postnatal wards:

- Ensure the baby is kept warm after birth and has skin-to-skin contact with the mother to provide warmth and to facilitate the initiation of feeding.

- Ensure that baby is offered the breast/milk within the first 60 minutes.

- Do not allow more than three hours to pass between feeds, until blood glucose measurements have been above 2.0mmol/l on two consecutive occasions.

- Measure the blood glucose level before the second feed (2-4 hours after birth). Measure blood glucose immediately if there are clinical signs suggestive of hypoglycaemia.

- If the first BG is 1.0 - 1.9mmol/l, 40% buccal dextrose gel (0.5ml/kg) may be given alongside feeding support: ongoing help with feeding; hand expression; recognition of early feeding cues and signs of effective attachment and feeding. For women who chose to formula feed, give 10-15ml/kg per feed 3 hourly over the first 24 hours after birth.

- If BG <1.0mmol/l, arrange for urgent medical review which will include siting an intravenous cannula for treatment with IV glucose.

- If BG is <1.0mmol/l, 40% buccal dextrose gel should only be used as an interim measure while arranging for treatment with IV glucose.

- Do not transfer babies with risk factors for impaired metabolic adaptation and hypoglycaemia to community care until you are satisfied that the baby is maintaining blood glucose levels ≥ 2.0mmol/l on at least two consecutive occasions and is feeding well. Infants at risk of hypoglycaemia should not be transferred to the community until they are at least 24 hours old.
3.2 Neonatal unit (NNU)

In unwell term and preterm infants admitted to the NNU, aim for BG ≥ 2.6mmols/l.

- If blood glucose is between 1 - 1.9mmol/l and has not improved following breast feeding support and/or bottle/cup top up or infant not taking adequate amount of milk orally but tolerating enteral feeds, consider siting nasogastric tube and providing full enteral feeds via nasogastric tube.

- If the blood glucose level is less than 1.0mmol/l, give a bolus of 2.5mls/kg 10% dextrose and immediately start an intravenous infusion of 10% dextrose at 75mls/kg/day (one day ahead). Recheck the blood sugar after 30 minutes.

- If the repeat blood sugar remains <1.0mmol/l repeat the dextrose bolus and increase the glucose delivery by 2mg/kg/min by increasing the volume or concentration of glucose infusion.

- If the blood sugar is <2.6mmols/l but increasing, increase the glucose delivery by 2mg/kg/min by increasing the volume or concentration of glucose infusion.

- 10% and 12.5% dextrose solution can be given peripherally but a higher concentration of dextrose (15%, 20%) can only be given via a central venous line. Consider getting a central venous access early (UVC or peripheral long line).

- If glucose utilisation is >8mg/kg/min, consider hyperinsulinaemic hypoglycaemia (see section 9).

Calculation of glucose delivery rates:
Normal glucose utilisation rates are 4-6mg/kg/min. Infants in the high-risk groups or those with other pathologies frequently require 6-10mg/kg/min.

Glucose delivery = \[
\frac{(\text{ml/hr infusion rate}) \times (\% \text{ Dextrose Infusion}) \times 10}{(\text{weight in kg}) \times 60}
\]

Table 4: Glucose delivery rate

<table>
<thead>
<tr>
<th>Rate of glucose delivery (mg/kg/min)</th>
<th>Strength of IV glucose solution</th>
<th>10%</th>
<th>12.5%</th>
<th>15%*</th>
<th>20%*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid infusion rate (ml/kg/d)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>4.2</td>
<td>5.2</td>
<td>6.3</td>
<td>8.3</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>6.3</td>
<td>7.8</td>
<td>9.4</td>
<td></td>
<td>12.5</td>
</tr>
<tr>
<td>100</td>
<td>6.9</td>
<td>8.7</td>
<td>10.4</td>
<td></td>
<td>13.9</td>
</tr>
<tr>
<td>120</td>
<td>8.3</td>
<td>10.4</td>
<td>12.5</td>
<td></td>
<td>16.7</td>
</tr>
<tr>
<td>150</td>
<td>10</td>
<td>13</td>
<td>15.6</td>
<td></td>
<td>20.8</td>
</tr>
</tbody>
</table>

*15% and 20% glucose solutions must be delivered via a central line.
Glucose delivery rates in white (in black boxes) indicate the need for investigating for hyperinsulinaemia, particularly when required at > 48 hours of age.
4 Management of preterm infants (<37 weeks) with hypoglycaemia

Preterm neonates are predisposed to developing hypoglycaemia due to their limited glycogen and fat stores, higher metabolic demands due to a relatively larger brain size, and are unable to mount a counter-regulatory response to hypoglycaemia with an inability to generate new glucose using gluconeogenesis pathways.

The management of preterm infants with hypoglycaemia is related to their gestation and other comorbidities:

‘Late preterm’ infants (34 to 36 week infants) cared for on the postnatal wards may be managed in the same way as term infants using Flowcharts A to C. Blood glucose target should be ≥ 2mmol/l. Admission to the neonatal unit should be considered for poor feeding at this gestation.

For all other preterm infants use Flowchart E. Management of Hypoglycaemia on the Neonatal Unit

In unwell term and preterm infants admitted to the NNU, aim for BG ≥ 2.6mmol/l.

If the blood glucose level is less than 1.0mmol/L, give a bolus of 2.5mls/kg 10% dextrose and immediately start an intravenous infusion of 10% dextrose at 75mls/kg/day (one day ahead) (100mls/kg/day if <1kg). Recheck the blood sugar after 30 minutes.

• If the repeat blood sugar remains <1.0mmol/l ensure that the baby is receiving the glucose infusion. Check that the cannula/UVC is functioning and not blocked/dislodged/extravasated. If the baby is receiving the glucose infusion, then repeat the bolus and increase the volume or concentration of the glucose infusion.

• If the blood sugar is < 2.6mmol/l but increasing, there a short period of observation with frequent blood sugars (30mins to hourly until the blood sugar is ≥ 2.6 mmol/l and stable). If the blood sugar is failing to increase to ≥ 2.6 mmol/l then increase the volume or concentration of glucose infusion. Higher concentration of dextrose (15%, 20%) can only be given via a central venous line.

• Aim to start parenteral nutrition as soon as possible.

Hyperglycaemia is more common in preterm infants (see hyperglycaemia guideline)
5 Weaning From IV Dextrose

The aim of effective weaning from IV dextrose is to prevent hypoglycaemic episodes but also to prevent excessive glucose monitoring. This weaning plan will not be applicable to infants with hyperinsulinaemic hypoglycaemia.

5.1 Breast or Bottle Fed Infants

A well term infant in whom hypoglycaemia has resolved, demand feeding can be established and IV 10% dextrose can be reduced quite quickly:

- Decrease the dextrose concentration from 20% to 15% to 10% as tolerated before decreasing the volume
- Halve and then stop dextrose infusion if BG maintained but if this is not possible
- Decrease by 1-2 ml every 4-6 hours as long as the glucose is ≥ 2.6mmol/l
- Check a pre-feed BG (before next feed) after any decrease in IV dextrose infusion rate to ensure the change is tolerated
- Ensure that a blood glucose is measured pre-feed once the IV has stopped

5.2 Infant Establishing Nasogastric (NG) Feeds

Once the infant is able to tolerate increased volume of nasogastric feeds

- Increase the NG feeds and decrease the IV by 1-2 ml every 4-6 hours as long as the glucose is maintained ≥ 2.6mmol/l
- Check a pre-feed BG (before next feed) following decrease in IV dextrose infusion
- Continue to feed 2 hourly by NG until the IV has stopped
- Check pre-feed blood glucose once the IV has stopped
- Thereafter increase time between feeds and normalise to either breast feeding or bottle feeds as per maternal preference

6 Investigations for hypoglycaemia

Transient hypoglycaemia defined as ONE measurement of 1.0 - 1.9 mmol/l within the first 48 hours after birth in a term infant with NO abnormal signs who is feeding effectively does not require investigation [1].

In the absence of clearly identifiable risk factors (as in Table 2) or if the infant has hypoglycaemic encephalopathy with abnormal neurological signs, admit the infant to NNU for neurocritical care, investigation and treatment of the underlying cause of hypoglycaemia. Investigations should be undertaken when the BG levels are low.

Indication for investigation for neonatal hypoglycaemia

- Persistent hypoglycaemia: 3 or more BG <2.0mmol/l within the first 48 hours after birth
- Severe hypoglycaemia: BG <1.0mmol/l at any time
- Symptomatic hypoglycaemia: BG <2.6mmol/l with signs/symptoms of hypoglycaemia
- Infants with a glucose utilisation of >8mg/kg/min

Undertake thorough clinical examination of the baby from head to toe looking for any dysmorphic features such as coloboma, cleft palate, congenital heart disease, exomphalos, organomegaly, ambiguous genitalia. Consider evaluation for early onset sepsis.

NB: Paper copies of guidelines may not be the most recent version. The definitive version is held on the Sharepoint and the Badgernet guideline library.
Table 5: Investigations for neonatal hypoglycaemia

**NEONATAL HYPOGLYCAEMIA SCREEN**

**PLEASE RE-FILL BAG WITH THE CORRECT BOTTLES & GUTHRIE CARD AFTER USE**

<table>
<thead>
<tr>
<th>Test</th>
<th>Container</th>
<th>Volume</th>
<th>On ice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulin C-peptide</td>
<td>Orange top[lithium heparin]</td>
<td>1ml</td>
<td>Yes</td>
</tr>
<tr>
<td>Ammonia</td>
<td>Orange top[lithium heparin]</td>
<td>1ml</td>
<td>Yes</td>
</tr>
<tr>
<td>Lactate</td>
<td>Yellow top[fluoride]</td>
<td>1ml</td>
<td>Yes</td>
</tr>
<tr>
<td>Free fatty acids B-hydroxybutyrate</td>
<td>Yellow top[fluoride]</td>
<td>1ml</td>
<td></td>
</tr>
<tr>
<td>Glucose</td>
<td>Yellow top[fluoride]</td>
<td>0.5ml</td>
<td></td>
</tr>
<tr>
<td>Cortisol</td>
<td>White top[serum]</td>
<td>1ml</td>
<td></td>
</tr>
<tr>
<td>Plasma amino acids</td>
<td>Orange[lithium heparin]</td>
<td>1ml</td>
<td></td>
</tr>
<tr>
<td>Carnitine (free and total)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acyl-carnitine</td>
<td>Guthrie card</td>
<td>4 spots</td>
<td></td>
</tr>
<tr>
<td>Urine reducing substances</td>
<td>Universal container</td>
<td>5mls</td>
<td></td>
</tr>
<tr>
<td>Urine organic acids</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urine Ketones</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL = 3 Orange + 3 Yellow + 1 white topped bottles**

**(Send 2 orange + 1 yellow on Ice)**

**TAKE FULL AMOUNT OF BLOOD**

Consider:
- Ophthalmology examination
- Cranial USS or Brain MRI – for suspected septo-optic dysplasia

Further investigations should be based on the results of the initial screen and taken following specialist advice.
7 Persistent low blood glucose measurement

Persistent hypoglycaemia can be the first sign of hyperinsulinism or another metabolic disorder. Early detection of this group of infants is important because specific interventions designed to reduce the risk of brain injury may be required along with specific long-term treatment and management.

Persistent hypoglycaemia (HH, or 'hyperinsulinism') should be considered if:
- BG <2.0mmol/l on three or more occasions in first 48 hours despite adequate energy provision and a feeding plan
- Symptomatic hypoglycaemia
- If a glucose utilisation is greater than 8mg/kg/min

These cases must be discussed with the Duty Neonatal Consultant and a referral to the Paediatric Endocrinology team should be considered.

HH is a heterogeneous condition caused by dysregulation of insulin secretion from pancreatic beta cells. This condition is associated with several recognisable syndromes and disorders:
- Maternal diabetes
- Erythroblastosis (e.g. severe Rhesus disease)
- Insulinoma or Neonatal Hyperinsulinaemic Hypoglycaemia (nesidioblastosis)
- Beckwith-Wiedemann Syndrome
- Turner’s Syndrome
- Soto’s Syndrome
- Costello Syndrome
- Prader-Willi Syndrome

Other causes of persistent hypoglycaemia include:
1. Endocrine Causes
   - Panhypopituitarism
   - Hypothyroidism
   - Growth hormone deficiency
   - ACTH unresponsiveness
2. Inborn Errors of Metabolism
   - Carbohydrate metabolism: Galactosaemia, Glycogen Storage Disease, Fructose Intolerance
   - Amino Acid metabolism: Maple Syrup Urine Disease, Propionicacidaemia, MethyImalonicacidaemia, Hereditary Tyrosinaemia

Sometimes there may be diagnostic clues such as hyperpigmentation of the skin suggesting the diagnosis of familial glucocorticoid deficiency (FGD) or ambiguous genitalia, but no other signs may be present and extensive laboratory evaluation is required, guided by specialist advice.

If HH is suspected, diagnosis should be made promptly by confirming high plasma insulin levels and BG levels should be maintained > 3.0mmol/l.
### Table 7: Treatment of hyperinsulinaemic hypoglycaemia

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diazoxide</td>
<td>Total daily dose up to 20 mg/kg/day in 2 – 3 divided doses, in combination with a thiazide diuretic.</td>
</tr>
<tr>
<td>Hydrochlorothiazide</td>
<td>Total daily dose up to 7.5 mg/kg/day in 2 divided doses.</td>
</tr>
<tr>
<td>Chlorothiazide</td>
<td>Total daily dose up to 10 mg/kg/day in 2 divided doses.</td>
</tr>
<tr>
<td>Octreotide</td>
<td>10 micrograms/kg/day as a continuous infusion.</td>
</tr>
<tr>
<td>Glucagon infusion</td>
<td>10 microgram/kg/hour by infusion.</td>
</tr>
</tbody>
</table>

Diazoxide can cause both sodium and water retention causing a potential risk of both hyponatraemia or hypernatraemia and pulmonary hypertension. Strict monitoring of fluid balance is required. Chlorthiazide is given alongside diazoxide to reduce the risk of fluid retention, as well as potentiating its glycaemic effect. Referral by the Paediatric Endocrinologist to a centre skilled in the management of these conditions may be required.

### 8 Documentation

Neonatal hypoglycaemia may be an early sign of other significant disease processes, which will require further investigation. It is also becoming an important aspect in medico-legal cases involving babies. For these reasons, make accurate contemporaneous documentation of events, containing the following in baby’s clinical case notes.

- Time when hypoglycaemia was noted
- Infant’s clinical condition when hypoglycaemia noted
- Blood glucose concentration - noting the method by which it was measured
- Nature of treatment instituted
- Nature and timing of the clinical response to treatment
- Confirmation of improvement in blood glucose
Flowchart A. Management of term infants (≥37 weeks) at risk of hypoglycaemia (Box 1)

- Dry and place baby skin-to-skin care in a warm, draught free room.
- Put hat on baby, and cover with a warm blanket.
- Encourage and support early breast feeding within the first hour after birth.
- For women who chose to formula feed give 10-15ml/kg within the first hour after birth.
- Provide verbal and written information to parents that explains how to prevent hypoglycaemia, why their baby needs blood glucose monitoring, lists signs that may indicate hypoglycaemia (see Box 2), and advises parents to inform a member of the healthcare team if they are concerned about their baby’s well-being (Appendix 1).

Check pre-feed blood glucose level prior to second feed (2-4 hours after birth): Is the blood glucose level ≥2.0mmol/l?

- Encourage frequent feeding and ensure no longer than 3 hours between feeds.
- Assess the need for helping the mother with: ongoing help with feeding; hand expression; recognition of early feeding cues; and signs of effective attachment and feeding.
- For women who chose to formula feed, give 10-15ml/kg per feed 3 hourly over the first 24 hours after birth.
- Check blood glucose level prior to third feed (no longer than 8 hours after birth): Is the blood glucose level ≥2.0mmol/l?

See Flowchart B

- Continue to support responsive breast feeding and ensure that mother understands how to assess effective feeding and knows how to escalate concerns.
- If formula fed give 10-15ml/kg per feed 3 hourly over the first 24 hours after birth.
- No further blood glucose monitoring required unless there are clinical signs of hypoglycaemia (Box 2).
- Observe feeding for 24 hours.
- Complete at least one recorded breastfeeding assessment using local / BFI tool prior to transfer home.

Box 1. Infants who require routine blood glucose monitoring
- Preterm neonate <37 weeks
- Infants of diabetic mothers
- Maternal beta blocker use
- Intrauterine growth restriction (<2nd centile for gestation)
- Large for gestational age (≥97th centile for gestation)

Box 2. Signs that may indicate hypoglycaemia
- Lethargy
- Abnormal feeding behaviour especially after a period of feeding well
- High pitched cry
- Altered level of consciousness
- Hypotonia
- Seizures
- Hypothermia (<36.5°C)
- Cyanosis
- Apnoea
Flowchart B. Pre-feed BG 1.0 – 1.9mmol/l and no abnormal clinical signs

Does the baby have clinical signs consistent with hypoglycaemia (Box 1)?

**NO**
- **Repeat one loop, then see Box 3.**

**YES**
- **See Flowchart C**

**Box 1. Signs that may indicate hypoglycaemia**
- Lethargy
- Abnormal feeding behaviour especially after a period of feeding well
- High pitched cry
- Altered level of consciousness
- Hypotonia
- Seizures
- Hypothermia (<36.5°C)
- Cyanosis
- Apnoea

**Box 2. Supporting breast feeding**
- Encourage skin-to-skin contact.
- Offer breast feed and if not feeding effectively teach mother to hand express.
- Give colostrum obtained to baby by the method suitable to parents.
- Continue to encourage hand expression at least 8-10 times in 24 hours and support feeding on the breast until infant is feeding effectively.

**Box 3. If more than 2 measurements 1.0-1.9mmol/l, inform neonatal team.**
- Investigate for causes of hypoglycaemia, consider sepsis.
- Consider increased feed frequency, nasogastric tube insertion or IV infusion of 10% glucose.

- Consider administration of 40% buccal dextrose gel 200mg/kg as part of feeding plan (Appendix 3).
- Support breast feeding (see Box 2).
- If mother is choosing to formula feed, aim to deliver 10-15ml/kg in 3 hourly feed volumes.
- Recheck blood glucose before third feed, no later than 8 hours after birth.
- Is the blood glucose level ≥ 2.0mmol/l?

**YES**
- Give feed: breast feed and/or offer expressed breast milk.
- For formula fed infants give 10-15ml/kg in 3 hourly feed volumes.
- Recheck blood glucose before next feed.
- Is the blood glucose level ≥ 2.0mmol/l?

**YES**
- Continue to support responsive breastfeeding.
- After 2 consecutive pre-feed BG measurements ≥ 2.0mmol/l discontinue BG monitoring unless there are abnormal clinical signs (Box 1), in which case use Flowchart C
- Observe feeding for 24 hours.
- Complete at least one recorded breastfeeding assessment using local / BFI tool prior to transfer home.

Flowchart C. Blood glucose < 1.0mmol/l and / or clinical signs consistent with hypoglycaemia

Obtain intravenous (i.v.) access.
Collect blood sample for: laboratory confirmation of blood glucose, hypoglycaemia screening tests and site a urine bag.
Consider screening and treatment for sepsis.
Admit to Neonatal Unit.

Unable to obtain immediate IV access

Give i.v. 10% glucose 2.5ml/kg.
Start IV infusion of 10% glucose at 75ml/kg/d (one day ahead)

40% dextrose gel 200mg/kg (0.5ml/kg) massaged into the buccal mucosa can be given while i.v. access is obtained OR intramuscular glucagon (200micrograms/kg)

Do not stop the establishment of breast feeding unless the baby is too sick to feed or there is a clinical contraindication to enteral feeding.
Support expression of breast milk.
In formula fed infants, continue feeds if no contraindication to enteral feeding.
Recheck blood glucose after 30 minutes.

BG <1.0mmol/l or abnormal clinical signs.
Give IV 10% glucose 2.5ml/kg.
Increase glucose delivery rate by 2mg/kg/minute by increasing volume and/or concentration of glucose infusion*.
Recheck BG after 30 minutes.
Repeat cycle if BG <1.0mmol/l or there are abnormal clinical signs.

BG 1.0-2.5mmol/l and no abnormal clinical signs?
Increase glucose delivery rate by 2mg/kg/minute by increasing volume and/or concentration of glucose infusion*.
Continue to feed if no contraindication.
Recheck blood glucose after 30 min.

BG >2.5mmol/l.
Slow wean of i.v. infusion.
Continue enteral feeds.
Continue to monitor BG until infant is on full enteral feeds and blood glucose values are >2.5mmol/l or 3.0mmol/l in cases of hyperinsulinism over several fast-feed cycles for at least 24 hours.

*If glucose infusion rate >8mg/kg/min, test for hyperinsulinism
Flowchart D. Management of reluctant feeding in healthy term infants ≥ 37 weeks

6-8 hours following birth.
- Second feed completed?
- Fed effectively?

YES

1-2 hours following birth.
- Maintain skin-to-skin contact.
- Review in 1-2 hours.
- Assess well-being of the baby and record observations on new-born observation chart.
- If breastfeeding encourage mother to hand express and give small amounts of colostrum to baby
- Fed Effectively?

NO

Initiate active feeding plan**

Birth
- Dry baby/ keep warm.
- Initiate and maintain skin to skin contact for at least 1 hr or until after 1st feed.
- Encourage responsiveness with mother.
- Discuss signs of readiness to feed.
- First feed in skin to skin contact preferably within 1 hour.
- For babies being fed formula follow the chart but give formula milk instead of colostrum.
- Fed effectively?

NO

YES

Monitor well-being of baby at least 4 hourly*
- Check:
  - Any maternal concerns.
  - Colour.
  - Tone.
  - Respiratory well-being.
  - Temperature.
  - Alertness / level of consciousness.
  - Number and consistency of wet and dirty nappies.
  - Risk for sepsis.
- If any signs of illness refer to neonatal team.
- Any concerns about possible hypoglycaemia or ill-health refer to relevant guideline.

Complete initial Breastfeeding assessment.
- Within 6 hours of birth or once feeding initiated.
- Assess:
  - Signs of effective feeding.
  - Pain free.
  - Maternal concerns.
  - Breast / nipple damage.
  - Baby readiness to feed.
- Monitor well-being*

Monitor well-being of baby at least 4 hourly*
- Continue feeding issue resolves.

Once the baby is feeding successfully. Breastfeeding assessments as per local guidelines.

Active feeding plan**
- Maintain skin contact.
- Review every 2 - 4 hours.
- Actively encourage breast feeding.
- Offer feeds according to feeding cues at least 8-10 times in 24 hours when feeding is established.
- If breast feeding: hand express at least 8-10 times in 24 hours (commence pumping when milk comes in if mother chooses to do so)
- Continue to give expressed breast milk and actively support until successfully breast feeding.
- Avoid teats, dummies and nipple shields.
- Support mother and listen/ action any concerns voiced regarding ill-health.
- Refer to neonatal team if any concerns.
- Monitor well-being of baby at least 4 hourly*
- Continue feeding issue resolves.
Flowchart E. Management of Hypoglycaemia on the Neonatal Unit

Baby has:
- Symptomatic Hypoglycaemia OR
- Significant hypoglycaemia (BG <1.0mmol/l)

Is the Infant tolerating oral feeds?

Yes

Breast or Bottle feeding
- Increase frequency and volume of feeds up to 10ml/kg/feed 2hrly
- May need to express or supplement with formula if breast feeding
- Re-check BG after 1hour and later do pre-feed if stable
- THE TARGET BG IS ≥2.6mmol/l
- Consider NGT feeding if persisting low BG
- Increase time between feeds after three consecutive BG of ≥2.6mmol/l
- Stop checking BG when three consecutive BG ≥2.6mmol/l while on 3hrly feeding

No

NGT feeding
- Give EBM or formula feeds up to 10ml/kg/feed 2hrly
- Re-check BG after 1hour and later do pre-feed if stable
- THE TARGET BG IS ≥2.6mmol/l
- Hourly feeding can be given if bolus feeding is not tolerated
- Consider increasing time between feeds after three consecutive BG of ≥2.6mmol/l on 2hrly feeds
- Try establishing breast / bottle feeding after three consecutive BG of ≥2.6mmol/l on 3hrly feeding.
- Stop checking BG when three consecutive BG ≥2.6 while on 3hrly breast / bottle

Recheck BG after 30mins

AIM for a BG ≥2.6mmol/l

- Increase volume or concentration of dextrose to achieve target BG
- If further boluses are required follow this by increasing maintenance glucose and check effect after 30mins
- Do not exceed 150ml/kg/day of IV fluids
- Continue oral feeding if tolerated
- Use central access if >12.5% Dextrose is needed
- Check BG no more than 4 hourly when stable

If despite attempts at enhanced enteral feeding the BG continue to be <2.6mmol/l on three consecutive occasions CONSIDER IV THERAPY

If glucose delivery rate is >8mg/kg/min AND Persisting low BG CONSIDER HYPERINSULINISM (see below)

Wean IV fluids after 6-12hrs and three consecutive BG ≥2.6mmol/l (see below)
9 Auditable standards
1. Infants of Diabetic Mothers and term babies with birth weight < 2nd centile or >4.5kg are identified at birth, screened and managed to prevent hypoglycaemia (100% target)
2. Infants admitted to NNU with significant or symptomatic hypoglycaemia are managed according to the guideline.

10 References
Appendix 1: Use of dextrose gel

Indications:
- Blood glucose 1.0-1.9mmol/l in infant with no abnormal clinical signs
- Infants ≥ 35 weeks’ gestational age and younger than 48 hours after birth

Note:
Must be used in conjunction with a feeding plan
For babies with severe hypoglycaemia (BG <1.0mmol/l) use oral dextrose gel only as an interim measure while arranging for urgent medical review and treatment with IV glucose

Dose:
Use 200mg/kg of 40% dextrose gel (0.5 ml/kg of 40% dextrose gel), up to two doses given 30 minutes apart per episode of hypoglycaemia and a maximum of six doses of buccal dextrose gel in 48 hours.

<table>
<thead>
<tr>
<th>Weight of baby (kg)</th>
<th>Volume of gel (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5-1.99</td>
<td>1</td>
</tr>
<tr>
<td>2.0-2.99</td>
<td>1.5</td>
</tr>
<tr>
<td>3.0-3.99</td>
<td>2.0</td>
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<tr>
<td>4.0-4.99</td>
<td>2.5</td>
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<tr>
<td>5.0-5.99</td>
<td>3.0</td>
</tr>
<tr>
<td>6.0-6.99</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Method of administration
- Draw up correct volume of 40% dextrose gel (Glucogel) using a 2.5 or 5ml oral / enteral syringe
- Dry oral mucosa with gauze, gently squirt gel with syringe (no needle) onto the inner cheek and massage gel into the mucosa using latex-free gloves
- Offer a feed preferably breast milk, immediately after administering dextrose gel
- Repeat blood sugar measurement as requested
- Repeat oral dextrose gel if baby remains hypoglycaemic according to flow chart

Up to 6 doses can be given over a 48-hour period but any more than one dose should be discussed with the neonatal team and it is advisable for the baby to be examined before the 3rd dose is administered.
Appendix 2: Parent information

PROTECTING YOUR BABY FROM LOW BLOOD GLUCOSE

What is low blood glucose?
You have been given this leaflet because your baby is at increased risk of having low blood glucose (also called low blood sugar or hypoglycemia).
Babies who are small, premature, unwell at birth, whose mothers are diabetic or have taken certain medication (beta-blockers) or very big babies, may have low blood glucose in the first few hours and days after birth, and it is especially important for these babies to keep warm and feed as often as possible in order to maintain normal blood glucose levels.

If your baby is in one of these “at risk” groups, it is recommended that they have some blood tests to check their blood glucose level. Extremely low blood glucose, if not treated, can cause brain injury resulting in developmental problems. If low blood glucose is identified quickly, it can be treated to avoid harm to your baby.

Blood glucose testing
Your baby’s blood glucose is tested by a heel-prick blood test. A very small amount of blood is needed and it can be done while you are holding your baby in skin-to-skin contact. The first blood test should be done before the second feed (2-4 hours after birth), and repeated until the blood glucose levels are stable.
You and your baby will need to stay in hospital for the blood tests. You will know the result of the test straight away.

How to avoid low blood glucose

• **Skin-to-skin contact** Skin-to-skin contact with your baby on your chest helps keep your baby calm and warm and helps establish breastfeeding. During skin-to-skin contact your baby should wear a hat and be kept warm with a blanket or towel.

• **Keep your baby warm** Put a hat on your baby for the first few days while he / she is in hospital. Keep your baby in skin contact on your chest covered with a blanket and look into you babies eyes to check his / her well-being in this position, or keep warm with blankets if left in a cot.

• **Feed as soon as possible after birth** Ask a member of staff to support you with feeding until you are confident, and make sure you know how to tell if breastfeeding is going well, or how much formula to give your baby.

• **Feed as often as possible in the first few days** Whenever you notice “feeding cues” which include rapid eye movements under the eyelids, mouth and tongue movements, body movements and sounds, sucking on a fist, offer your baby a feed. Don’t wait for your baby to cry – this can be a late sign of hunger.

• **Feed for as long, or as much, as your baby wants**. To ensure your baby gets as much milk as possible.
- **Feed as often as baby wants, but do not leave your baby more than 3 hours between feeds.** If your baby is not showing any feeding cues yet, hold him/her skin-to-skin and start to offer a feed about 3 hours after the start of the previous feed.

- **Express your milk (colostrum).** If you are breastfeeding and your baby struggles to feed, try to give some expressed breast milk. A member of staff will show you how to hand express your milk, or watch the UNICEF hand expression video (search “UNICEF hand expression”). If possible, it is good to have a small amount of expressed milk saved in case you need it later, so try to express a little extra breast milk in between feeds. Ask your midwife how to store your expressed milk.

- **Don’t hesitate to tell staff if you are worried about your baby** If your baby appears to be unwell, this could be a sign that they have low blood glucose. As well as doing blood tests, staff will observe your baby to check he/she is well, but your observations are also important, as you are with your baby all the time so know your baby best. **It is important that you tell staff if you are worried** that there is something wrong with your baby, as parents’ instincts are often correct.

The following are signs that your baby is well:

- **Is your baby feeding well?** In the first few days your baby should feed effectively at least every 3 hours, until blood glucose is stable, and then at least 8 times in 24 hours. Ask a member of staff how to tell if your baby is attached and feeding effectively at the breast, or how much formula he/she needs. If your baby becomes less interested in feeding than before, this may be a sign they are unwell and you should raise this with a member of staff.

- **Is your baby warm enough?** Your baby should feel slightly warm to touch, although hands and feet can sometimes feel a little cooler. If you use a thermometer the temperature should be between 36.5°C and 37.5°C inclusive.

- **Is your baby alert and responding to you?** When your baby is awake, he/she will look at you and pay attention to your voice and gestures. If you try to wake your baby, they should respond to you in some way.

- **Is your baby’s muscle tone normal?** A sleeping baby is very relaxed, but should still have some muscle tone in their body, arms and legs and should respond to your touch. If your baby feels completely floppy, with no muscle tone when you lift their arms or legs, or if your baby is making strong repeated jerky movements, this is a sign they may be unwell. It can be normal to make brief, light, jerky movements. Ask a member of the team if you are not sure about your baby’s movements.

- **Is your baby’s colour normal?** Look at the colour of the lips and tongue – they should be pink.

- **Is your baby breathing easily?** Babies’ breathing can be quite irregular, sometimes pausing for a few seconds and then breathing very fast for a few seconds. If you notice your baby is breathing very fast for a continuous period (more than 60 breaths
per minute), or seems to be struggling to breathe with very deep chest movements, nostrils flaring or making noises with each breath out – this is not normal.

**Who to call if you are worried**
In hospital, inform any member of the clinical staff.

**What happens if your baby's blood glucose is low?** If the blood glucose test result is low, your baby should feed as soon as possible and provide skin-to-skin contact. If the level is very low the neonatal team may advise urgent treatment to raise the blood glucose and this could require immediate transfer to the Neonatal Unit.

Another blood glucose test will be done before the next feed or within 2-4 hours or sooner of clinically indicated.

If you are breastfeeding and your baby does not breastfeed straight away, a member of staff will review your baby to work out why. If he / she is happy that your baby is well, s/he will support you to hand express your milk and give it by oral syringe / finger / cup / spoon.

If your baby has not breastfed, and you have been unable to express any of your milk, you will be advised to offer infant formula.

The team may prescribe a dose of dextrose (sugar) gel as part of the feeding plan because this can be an effective way to bring your baby’s glucose level up.

If you are breastfeeding and advised to give some infant formula, this is most likely to be for one or a few feeds only. You should continue to offer breastfeeds and try to express milk as often as possible to ensure your milk supply is stimulated.

Very occasionally, if babies are too sleepy or unwell to feed, or if the blood glucose is still low after feeding, he / she may need to go to the Neonatal Unit / Special Care Baby Unit. Staff will explain any treatment that might be needed. In most cases, low blood glucose quickly improves within 24-48 hours and your baby will have no further problems.

**Going home with baby**

It is recommended that your baby stays in hospital for 24 hours after birth. After that, if your baby’s blood glucose is stable and he / she is feeding well, you will be able to go home.

Before you go home, make sure you know how to tell if your baby is getting enough milk. A member of staff will explain the normal pattern of changes in the colour of dirty nappies and number of wet/dirty nappies. For further information, if you are breastfeeding, see ‘How you and your midwife can recognise that your baby is feeding well’ (Search ‘UNICEF Baby Friendly assessment tool’).
It is important to make sure that your baby feeds well at least 8 times every 24 hours and most babies feed more often than this.

There is no need to continue waking your baby to feed every 2–3 hours as long as he / she has had at least 8 feeds over 24 hours, unless this has been recommended for a particular reason. You can now start to feed your baby responsively. Your midwife will explain this.

If you are bottle feeding, make sure you are not overfeeding your baby. Offer the bottle when he / she shows feeding cues and observe for signs that he / she wants a break. Don't necessarily expect your baby to finish a bottle – let him / her take as much milk as he/she wants.

Once you are home, no special care is needed. As with all newborn babies, you should continue to look for signs that your baby is well, and seek medical advice if you are worried at all about your baby.