

**Standard management for children with diabetes during surgery- Full Clinical Paediatric
Guideline – Joint Derby and Burton**

Reference no.: **CH CLIN D06/May 21/v008.1**

This guideline is intended for use in the management of children and young people up to 18 years of age with diabetes mellitus undergoing surgery under the care of the Paediatricians in Derby and Burton. It is important to avoid the immediate complications of diabetes peri-operatively, particularly hypoglycaemia and ketoacidosis.

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1. Introduction

Children with diabetes mellitus are at risk of blood glucose (BG) alterations when undergoing surgery. This risk results from a change in routine, change in or lack of perioperative insulin, physical and emotional stress related to the surgical procedure, surroundings, parental anxiety, and surgical pain. Adverse events which can occur include:

- Hypoglycaemia
- Hyperglycaemia

These can result from:

- Inappropriate use of intravenous insulin infusion
- Medication errors when converting from the intravenous insulin infusion to usual medication

For the above reasons, it is very important that every unit looking after children with diabetes requiring surgery has written guidelines. There should be close liaison between the surgeon, the anaesthetist and the paediatric diabetes team. Children with diabetes should not have to spend longer in hospital because their diabetes management has been unduly complicated.

2. Definitions

The peri-operative management of children who are on insulin treatment depends on their insulin regimen rather than on whether they have type 1 or type 2 diabetes mellitus.

Minor surgery: short procedures (usually less than 30 minutes) with or without sedation or anaesthesia where rapid recovery is anticipated and child is expected to be able to eat by the next meal. Examples include endoscopic biopsies, myringotomy, incision and drainage.

Major surgery: includes all surgery requiring more prolonged general anaesthesia lasting >30 minutes or a procedure which is likely to cause post-operative nausea, vomiting or inability to feed adequately. If you are unsure about the length of anaesthetic or risk of slow post-operative recovery from anaesthesia please discuss with anaesthetist

3. Preparation for elective surgery in all patients

Elective surgery should be postponed if the child/ young person has an HBA1c >75mmol/mol. Consider admission to hospital prior to elective surgery for assessment and stabilisation if this has not been achieved.

4. Pre-operative Assessment for Elective Surgery

Role of surgeon carrying out surgery/procedure:

- When a decision is made to undertake surgery, the surgeon should inform both the paediatric diabetes team and the anaesthetist about:
 - Date and timing of planned procedure. (if possible please put child first on the morning list)
 - The type of procedure and whether it is judged to be major or minor surgery as defined above

Role of the paediatric diabetes team:

- Try to optimise blood glucose levels prior to planned surgery
- Where possible, the paediatric diabetes consultant will write individual guidance depending on the patient's insulin requirements and type of surgery planned
- Ensure patients/ carers have clear written instructions regarding the management of the child's diabetes (including any medication adjustments) prior to surgery
- In Derby, admit to Sunflower ward if unlikely to need IV insulin. If IV insulin is required, admit to Dolphin Paediatric Critical Care Unit. In Burton, admit to Ward 1.
- Where the surgery is taking place in another hospital, the local diabetes team must inform the diabetes team in the other hospital in advance of the surgery.
- Basic information to be passed on includes:
 - Recent weight
 - Current diabetes treatment and most recent recorded doses
 - Most recent HbA1c (and date)
 - Hypoglycaemia awareness and any current issues with severe hypoglycaemia
 - Any co-morbidities (thyroid disorders/ Addison's disease/ Coeliac Disease)

5. Pre-operative Fasting Guidelines

- No solid food should be consumed for 6 hours before elective surgery in children.
- In infants, breast milk is safe up to 4 hours and other milks up to 6 hours before elective surgery. Thereafter, clear fluids should be given as in older children.
- Children should be encouraged to drink clear fluids (including water, low-sugar squash) up to 2 hours before elective surgery. Where this is not possible, then an intravenous-(IV) infusion should be started.

6. Peri-operative Blood Glucose Targets

- BG should be kept between 5-11.1mmol/l during the peri-operative period
- BG should be checked **at least hourly (before, during and after surgery)**.

There are no paediatric studies on the ideal BG targets to aim for peri-operatively. In adults, the implementation of intensive glycaemic control was associated with a higher number of patients experiencing hypoglycaemic episodes.

7. Guideline for Children Who Are Insulin Treated

7a. Minor Elective Morning Surgery

Day before surgery	<ul style="list-style-type: none"> • Advise normal insulin and diet • For those on insulin pumps, we recommend changing the cannula site.
Morning of procedure	<ul style="list-style-type: none"> • Child can be admitted on the morning of the surgery • Child should ideally be first on the list • IV cannula not needed on admission to the ward unless IV hypoglycaemia treatment is needed. • No IV fluids or insulin infusion needed • Measure and record the capillary BG hourly preoperatively and half hourly during the operation <p>For those patients on basal bolus regimen using multiple daily injection regimens: If BG is stable between 5-11.1mmol/L:</p> <p>Omit rapid-acting insulin (e.g insulin aspart, (NovoRapid or Fiasp), insulin lispro (Humalog), insulin glulisine (Apidra) in the morning until after procedure when they can have it with the late breakfast.</p> <ul style="list-style-type: none"> • If basal insulin (glargine (Lantus), detemir (Levemir) or degludec (Tresiba)) is usually given in the morning, give it as usual. Consider reducing the dose if blood sugar levels usually in target range. <p>For those patients on insulin pumps– Prior to surgery:</p> <ul style="list-style-type: none"> • Consider whether the pump may need to be removed if an X-ray expected in theatre. • Run the pump at the usual basal rate • Check BG hourly and ask parents to adjust basal rates to maintain BG between 5-11.1mmol/l <p>During surgery:</p> <ul style="list-style-type: none"> • Run the pump on the normal basal setting for the duration of the procedure. • BG should be checked hourly once nil by mouth and half hourly during the operation • Basal rate can be suspended for 30 minutes to correct any episodes of mild hypoglycaemia. If the pump is stopped for up to 1 hour, the child must be started on IV insulin and intravenous fluid (as per section 7F and 7G) as they have NO basal insulin in their body. <p>For those usually on premixed insulin in the morning, (Twice daily or three times daily regimen)</p> <ul style="list-style-type: none"> • delay the morning dose till after procedure when they can have it with a late breakfast <p>However, FOR ALL insulin regimes- If:</p> <ul style="list-style-type: none"> ▪ BG <5mmol/l – give bolus of IV 10% Glucose 2ml/kg; recheck BG 15 minutes later ▪ BG >12mmol/l – consider correction dose (usual for child). If no improvement, may need to start IV insulin infusion and IV fluids as per

	<p>sliding scale in section 7F and 7G.</p> <ul style="list-style-type: none"> ▪ If the procedure is delayed for a further 2 hours or child has had repeated low BGs, start on maintenance IV fluids (section 7F)
After procedure	<ul style="list-style-type: none"> • When well enough to eat, give usual dose of rapid acting insulin with the next meal (including correction dose if needed). • If needing IV fluids & insulin infusion - Go to section 7H for guide on how to change back to subcutaneous insulin. <p>Insulin pump regimen</p> <ul style="list-style-type: none"> • Allow parents to re-start the pump at the usual basal rate once the child has recovered. <p>Home when eating and drinking if surgeon happy. This is not dependent of current BG levels as the parent will manage those effectively at home with correction doses if needed.</p>

7b. Minor Elective Afternoon Surgery

Day before procedure	<ul style="list-style-type: none"> • Advise usual doses of insulin night before procedure • . For those on insulin pumps, we recommend changing the cannula site.
Morning of procedure	<ul style="list-style-type: none"> • Advise the child to have a normal breakfast no later than 7.30 a.m. • Patient to have breakfast insulin dose dependent on regimen: <p>If on a Multiple Daily injection (MDI) regimen,</p> <ul style="list-style-type: none"> • Give FULL usual dose of rapid-acting insulin (e.g insulin aspart (NovoRapid or Fiasp) or Humalog lispro (Humalog), insulin glulisine (Apidra) according to the carbohydrate content of breakfast as well as usual correction dose depending on pre-meal BG level (BG). • Glargine (Lantus), detemir (Levemir) or degludec (Tresiba), if usually given in the morning, should also be given. Consider reduction in the dose if blood sugar levels usually in target range. <p>If on a twice daily insulin regimen</p> <ul style="list-style-type: none"> • Give ½ of rapid-acting component of morning dose as rapid-acting insulin. Example: if usual morning dose is 10 units of Novomix 30, then the usual fast acting component is $3/10 \times 10 = 3$ units of rapid acting insulin e.g give 1.5 units of insulin aspart (NovoRapid). <ul style="list-style-type: none"> • Those children on insulin pumps- • Consider whether the pump may need to be removed if an X-ray expected in theatre. • Run the pump on the normal basal setting BG should be checked at least hourly. Carer/patient asked to alter infusion rate accordingly.
Peri-operatively	<ul style="list-style-type: none"> • Measure and record capillary BG on arrival • IV cannula not needed on admission to the ward unless IV hypoglycaemia treatment is needed. • Child should be first on the list • Measure and record capillary BG hourly once nil by mouth and half hourly during the operation • No IV fluids or insulin infusion needed routinely • However, if

	<ul style="list-style-type: none"> • BG <5mmol/l – give bolus of IV 10% glucose 2ml/kg; recheck BG 15 minutes later • If the procedure is delayed for a further 2 hours or child is continuing to have low BGs, start on maintenance IV fluids as in section 7F. • BG >12mmol/l – consider correction dose (usual for child). If no improvement, may need to start IV insulin infusion and IV fluids as per sliding scale in Section 7F and 7G • Children on insulin pumps should continue their pump as long as their BG remains between 5-11.1mmol/L • BG should be checked hourly pre-operatively and half-hourly during surgery • If BG <5 mmol/l suspend the pump for 30 minutes as well as giving glucose bolus (see above) • If the pump is stopped for up to 1 hour, the child must be started on IV insulin and intravenous fluid as per section 7F & 7G as they have NO basal insulin in their body.
After procedure	<ul style="list-style-type: none"> • Once eating, give usual dose rapid acting insulin generally taken with that meal • If needing IV fluids & insulin infusions, go to section 7H for guide on how to change back to subcutaneous insulin <p>Insulin pump regimen</p> <ul style="list-style-type: none"> • Allow parents to re-start the pump at the usual basal rate once the child has recovered. <p>Home when eating and drinking if surgeon happy. This is not dependent of current BG levels as the parent will manage those effectively at home with correction doses if needed.</p>

7c. Major Elective Morning Surgery

Day Before surgery	<ul style="list-style-type: none"> • Admit day before surgery • Weigh. Consider U&E, FBC, true BG, blood for ketones • Pre-meal and pre-bedtime capillary BG on the ward • Usual insulin the evening and night before surgery (consider reduction in basal insulin dose if BG usually in target). • For those on insulin pumps continue pump as usual with parental management until the time of surgery. We recommend changing the cannula site.
Morning of surgery *First on list*	<ul style="list-style-type: none"> • Nothing to eat 6 hours before operation. For morning lists patients should be starved from 03.00, but can drink clear fluids until 2 hours before surgery • Omit rapid acting insulin (e.g insulin aspart (NovoRapid or Fiasp) or Humalog lispro (Humalog), insulin glulisine (Apidra) in the morning. • Glargine (Lantus), detemir (Levemir) or degludec (Tresiba) if given in the morning, should also be given. Consider reduction in the dose if blood glucose levels usually in target range. • Start intravenous maintenance fluids at maintenance rate and intravenous insulin according to 'sliding scale' at 06.30h, to maintain BG level between 5 and 11.1mmol/l. (see section 7F & 7G) • Measure capillary BG pre-theatre and half-hourly during surgery <p>For those on an insulin pump:</p> <ul style="list-style-type: none"> • Consider whether the pump may need to be removed if an X-ray is expected in theatre. • Parents may be able to continue with their usual management and the team may advise a reduced temporary basal rate. If the pump needs to be stopped, start on IV insulin and intravenous fluid as per section 7F & 7G a few hours before surgery to gain stability.
After surgery:	<ul style="list-style-type: none"> • Capillary BG and Ketones hourly. • Continue IV fluids and IV insulin infusion until ready to start eating

	<ul style="list-style-type: none"> • Go to section 7H for guide on how to change back to subcutaneous insulin • Always give basal insulin analogue (Glargine (Lantus), detemir (Levemir) or degludec (Tresiba) by subcutaneous injection at usual time even if on IV fluids and insulin.
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7d. Major Elective Afternoon Surgery

Day before surgery	<ul style="list-style-type: none"> • Consider admission the day before surgery • Weigh. Consider U&E, FBC, true BG, blood for ketones • Pre-meal and pre-bedtime capillary BG on the ward • Usual insulin the evening and night before surgery (consider reduction in basal insulin dose if BG usually in target). • For those on insulin pumps continue pump as usual with parental management until a few hours before surgery. We recommend changing the cannula site. • The team may advise a reduced temporary basal rate. If the pump needs to be stopped, start on IV insulin and intravenous fluid as per section 7F & 7G a few hours before surgery to gain stability.
Morning of surgery **First on afternoon list**	<ul style="list-style-type: none"> • Light breakfast at 0700 on the morning of procedure before fasting, but check with anaesthetists for exact timing. • For those on a Multiple Daily Injection (MDI) regimen, rapid-acting insulin (should be given at the usual dose according to carbohydrate content as well as usual correction dose depending on pre-meal BG level. Glargine (Lantus), detemir (Levemir) or degludec (Tresiba) if given in the morning, should also be given. Consider reduction in the dose if blood glucose levels usually in target range. • For those on a twice daily insulin regime, give half the morning insulin dose • Intravenous fluid infusions from 12 noon and intravenous insulin infusion (see section 7F & 7G). • Measure capillary BG pre-theatre and half-hourly during surgery <p>For those on an insulin pump:</p> <ul style="list-style-type: none"> • Consider whether the pump may need to be removed if an X-ray is expected in theatre. • Parents may be able to continue with their usual management and the team may advise a reduced temporary basal rate. If the pump needs to be stopped, start on IV insulin and intravenous fluid as per section 7F & 7G a few hours before surgery to gain stability.
After surgery	<ul style="list-style-type: none"> • Capillary BG and Ketones hourly including theatre. • Continue IV fluids and IV insulin infusion until ready to start eating • Go to section 7H for guide on how to change back to subcutaneous insulin. • Always give basal insulin analogue (Glargine (Lantus), detemir (Levemir) or degludec (Tresiba) by subcutaneous injection at usual time even if on IV fluids and insulin.

7e. Emergency Surgery

Before surgery	<p>On arrival, weigh patient, measure capillary and plasma BG, venous blood gases, blood ketones, electrolytes, urea and creatinine.</p> <ul style="list-style-type: none"> • Inform diabetes team on admission if possible. <p>If ketoacidotic</p> <ul style="list-style-type: none"> • Follow Diabetes Ketoacidosis (DKA) guideline CH CLIN D03 • Operate when rehydrated, blood pressure is stable, blood gas is normal, sodium and potassium in normal range.
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	<ul style="list-style-type: none"> • Blood glucose levels should ideally be between 5 and 11.1mmol/l • This may not be possible for some life-saving operations. <p>If not ketoacidotic</p> <ul style="list-style-type: none"> • Follow guideline on major elective surgery and start fluid maintenance and intravenous insulin (section F & G) • For those on an insulin pump: • Consider whether the pump may need to be removed if an X-ray is expected in theatre. • Parents may be able to continue with their usual management and the team may advise a reduced temporary basal rate. If the pump needs to be stopped, start on IV insulin and intravenous fluid as per section 7F & 7G a few hours before surgery to gain stability. <p>Always give basal insulin analogue (Glargine (Lantus), detemir (Levemir) or degludec (Tresiba) by subcutaneous injection at usual time even if on IV fluids and insulin.</p>
After surgery	<ul style="list-style-type: none"> • Measure capillary BG hourly and check for blood ketones on every sample (including theatre) • Continue IV fluids and insulin infusion until ready to eat • Go to section 7H for guide on how to change back to subcutaneous insulin

7f. Maintenance Fluid Guide**Fluid of choice – 0.45% saline 5% glucose****Glucose:**

Use 5% glucose,

- however if there is concern about hypoglycaemia, use 10% glucose
- If BG is high (>12mmol/l) increase insulin supply. See Section 7G.

Sodium:

Use 0.45% saline. Change to 0.9% saline if sodium is falling.

Potassium:

Monitor electrolytes, but always include 20mmol potassium chloride in in 500ml bag intravenous fluid.

Maintenance fluid calculation

	Body weight in kg	Fluid requirements in 24 hours
For each kg between	3-9kg	100ml/kg
For each kg between	10-20kg	Add an additional 50ml/kg
For each kg over	Over 20kg	Add an additional 20ml/kg

7g. Insulin Infusion Guide

- Derby: Use 30 units soluble insulin (Actrapid) in 30 ml of 0.9% sodium chloride, giving 1 unit per ml.
- Burton: Add 50 units soluble insulin (Actrapid) to 49.5mls of 0.9% sodium chloride, giving 1 unit per ml.
- Start infusion at
 - 0.01 ml/kg/hour if BG is between 5–6mmol/l,

- 0.025 ml/kg/hour (i.e., 0.025 U/kg/hour) if BG is between 6–8mmol/l,
 - 0.05 ml/kg/hour if 8–12mmol/l,
 - 0.075 ml/kg/hour between 12–15mmol/l
 - 0.1 mlU/kg/hour if > 15mmol/l.
- Monitor BG hourly before surgery and every 30 minutes during the operation and until the child recovers from anaesthesia. Adjust IV insulin accordingly.
 - If BG <5mmol/l, stop the IV insulin infusion but only for 10–15 min. Give bolus of IV 10% glucose 2ml/kg; recheck BG 15 minutes later.

7h. Restarting subcutaneous insulin after being on intravenous insulin

If ready to eat **lunch** give:

- **For patients on twice** daily injection regime, e.g. Novomix 30, allow to eat but continue IV fluids and insulin until evening meal (then see below)
- **For patients on multiple daily injection regimes using** long-acting basal insulin analogues e.g. Glargine (Lantus), detemir (Levemir) or degludec (Tresiba): give rapid acting insulin (Novorapid, Fiasp or Humalog), insulin glulisine (Apidra) with lunch. Check that the long-acting insulin has been continued throughout stay. If they have missed a dose, delay re-starting subcutaneous insulin until they have had the long-acting insulin.
- **For those patients on an insulin pump** – re-start the insulin pump at the usual basal rate once the child is feeling better and BG levels are stable with no ketones. Parents should be allowed to manage according to their usual practice

If ready to eat by the **evening meal** give:

- **For those patients on twice** daily injection regime e.g. Novomix 30, give usual dose of insulin with evening meal.
- **For those patients on multiple daily injection regimes**, give rapid acting insulin (Novorapid, Fiasp or Humalog) Treating hypoglycaemia, insulin glulisine (Apidra) with the evening meal and long-acting insulin analogue e.g. Glargine (Lantus), detemir (Levemir) or degludec (Tresiba) at the usual time.
- **Always** give dose of long acting basal insulin analogue e.g. Glargine at the usual time even if still on intravenous fluids and intravenous insulin overnight to prevent rebound hyperglycaemia.
- **For those patients on an insulin infusion pump** – re-start the insulin pump at the usual basal rate once the child is feeling better and capillary BG levels are stable with no ketones. Parents should be allowed to manage according to their usual practice.

When to take down IV infusions:

- Stop IV insulin 60 minutes after subcutaneous insulin has started if the child is first given a pre mixed insulin (e.g. Novomix 30) or long acting basal insulin analogue dose.
- Stop IV insulin 10 minutes after subcutaneous insulin has started if the child is first given a rapid acting insulin dose/ re-started pump.

7i Treating hypoglycaemia

Peri-operatively, we consider BG levels <5mmol/l as hypoglycaemia (in comparison with our usual definition in diabetes of <4mmol/l).

For those children who 'are nil by mouth'

- BG <5mmol/l – give bolus of IV 10% glucose 2ml/kg; recheck BG 15 minutes later.
- If still nil by mouth, follow on with IV maintenance fluids (7f) until able to eat and drink.
- For those using an insulin infusion pump, suspend the pump for 30 minutes in addition to giving the glucose bolus.

For those children able to drink and eat, please follow guideline for the management of hypoglycaemia in children with diabetes (CH CLIN D05)

8. Guideline for children on oral medications

Metformin:

- Discontinue at least 24 hours before procedure for elective surgery.
- In emergency surgery and when metformin is stopped < 24 hours, ensure optimal hydration to prevent risk of lactic acidosis.
- The main concern regarding metformin therapy during surgery relates to the rare complication of lactic acidosis. Metformin has a long biological half-life (17-31 hours) hence the need to stop it at least 24 hours prior to surgery.

Other oral medications e.g. sulphonylureas or thiazolidinediones: stop on day of surgery

References:

Association of Children's Diabetes Clinicians Clinical Guideline: Care of children under 18 years with diabetes mellitus undergoing surgery. 2017

International Society of Paediatric and Adolescent Diabetes Clinical Practice consensus guideline 2018: management of children and adolescents with diabetes requiring surgery.

Document controls

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