

Management of Children and Adolescents with Diabetes Requiring Surgery

Key Document code:	WAHT-TP- 045	
Key Documents Owner:	Dr West	Consultant Paediatrician
Approved by:	Paediatric Quality Improvement meeting	
Date of Approval:	9 th February 2024	
Date of review:	9 th February 2027	
This is the most current document and should be used until a revised version is in place		

Key amendments to this guideline

Date	Amendment	Approved by:
19 TH Nov 2020	Document extended for 1 year	Dr J West/PaediatricQIM
26 th March 2021	Document reviewed and approved for 3 years	Paediatric Guideline Review Meeting
9 th February 2024	Guidance on hybrid closed loops added Section on MRI under GA added	Paediatric Guideline Review Meeting

Introduction

Children and young people with diabetes undergoing surgery require adjustments to their insulin schedule depending on the type of surgery (major or minor), the patient's insulin regimen, and the time of the surgical procedure (morning or afternoon). They are at risk of hypoglycaemic and hyperglycaemic events due to a change in routine, change in or lack of peri-operative insulin, physical and emotional stress related to the surgical procedure, surroundings, parental anxiety and surgical pain. Therefore, their surgical care needs to be planned.

The following guideline is for children and young people up to the age of 18 years and is based on those produced by the Association of Children's Diabetes Clinicians (ACDC)¹ and The International Society for Paediatric and Adolescent Diabetes (ISPAD)² but has been adapted for local use.

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 (always less than 2 hours, usually less than 30 minutes) with or without sedation or anaesthesia where rapid recovery is anticipated, and the child is expected to be able to eat by the next meal. Examples include endoscopic biopsies, myringotomy, incision and drainage, simple orthopaedic procedures.

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 an anaesthetist.

Glycaemic Targets Prior to Elective Surgery

Elective surgery should be postponed if possible if glycaemic control is very poor (HbA1c > 75mmol/mol [9.0%]). Consider admission to hospital prior to elective surgery for assessment and stabilisation if glycaemic control is poor. If control remains problematic, surgery should be cancelled and re-scheduled.

- There are currently no published data in children on the impact of pre-operative glycaemic control on post-operative outcomes. However, Dronge et al³ found that in adults, an HbA1c $\geq 7\%$ (53mmol/mol) more than doubles the risk of post-operative wound infection.

Pre-operative Assessment for Elective Surgery

Role of surgeon carrying out surgery/procedure:

As soon as the decision is made to undertake surgery, the surgeon needs to inform both the hospital paediatric diabetes team and the anaesthetist about:

- Date and timing of planned procedure (if possible please put child first on the morning list).
- 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 glycaemic control prior to elective surgery. If using a hybrid closed loop system, ensure the patient's basal rates in manual mode are similar to those in automode.
- Ensure patients have clear written instructions regarding the management of the child's diabetes (including any medication adjustments) prior to surgery.

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 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 intravenous fluid (IV) should be started.

Peri-operative BG 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.

Guidelines for Children who are Insulin Treated

Emergency Surgery

Diabetic ketoacidosis (DKA) may present as an 'acute abdomen' and illness may precipitate DKA.

- Inform the diabetes team on admission.
- Keep the patient nil by mouth.
- Weigh the patient and measure capillary and plasma blood glucose (BG), blood ketones, U&E and a capillary gas if the blood glucose is $>14\text{mmol/l}$ or ketones $>0.6\text{mmol/l}$.

If ketoacidotic:

- Follow hospital diabetic ketoacidosis guidelines.
- Operate when rehydrated, blood pressure is stable, blood gas is normal, sodium and potassium are in the normal range (may not be possible for some life-saving operations).
- Blood glucose levels should be stable, ideally between 5.0 and 11.1mmol/l.

If not ketoacidotic:

- Follow guideline below on major elective surgery and start intravenous maintenance fluids and intravenous insulin (see appendix).
- For those on insulin pumps (with or without a hybrid closed loop system), the pump should be stopped once the IV infusion is started.

Measure capillary BG and ketones hourly before, half hourly during and hourly after surgery.

Post-operatively

- Continue IV fluids and insulin infusion until ready to eat then change back to subcutaneous insulin (see appendix).
- Always give basal insulin analogue (subcutaneous insulin Glargine, Levemir or Tresiba) at usual time, even if still on IV fluids and insulin sliding scale.

Major Elective Surgery (Morning list)

- Liaise with the diabetes team well before the date of surgery.
- To be seen by a member of the diabetes team 2-3 weeks ahead to discuss control and pre- and post-operative management with child and parents.
- Admit day before surgery.

Pre-operatively

- Weigh the patient and measure FBC, U&E, true BG and blood ketones on admission.
- Check pre-meal and pre-bedtime capillary BG on the ward.
- Normal tea/supper with normal insulin (including basal insulin e.g. glargine) the evening and night before surgery.
- For those on insulin pump therapy (with or without a closed loop system), continue pump as usual until the time of surgery.

Morning of surgery

- Ensure patient is first on list.
- Patients should be starved from 03.00h but can drink clear fluids until 2 hours before surgery.
- Omit rapid-acting insulin in the morning.
- Glargine (Lantus), Detemir (Levemir) or Degludec (Tresiba) if given in the morning should be given in FULL.
- Start IV fluids at maintenance rate and IV insulin according to sliding scale at 06.30h aiming to keep BG level between 5.0 and 11.1 mmol/l (see appendix).
- Measure capillary BG hourly before and half-hourly during surgery.
- Patients on insulin pumps should continue their background insulin until IV fluids and insulin are started at which point the pump should be switched off.

Post-operatively

- Measure BG and ketones hourly.
- Continue IV fluids and IV insulin until taking adequate oral fluids and snacks then change back to subcutaneous insulin (see appendix).
- Always give basal insulin analogue (subcutaneous insulin glargine, Levemir or Tresiba) at usual time, even if still on IV fluids and insulin sliding scale.

Major Elective Surgery (Afternoon list)

- Liaise with the diabetes team well before the date of surgery.
- To be seen by a member of the diabetes team 2-3 weeks ahead to discuss control and pre- and post-operative management with child and parents.

- Admit day before surgery.

Pre-operatively

- Weigh the patient and measure FBC, U&E, true BG and blood ketones on admission.
- Check pre-meal and pre-bedtime capillary BG on the ward.
- Normal tea/supper with normal insulin (including basal insulin e.g. Glargine, Levemir or Tresiba) the evening and night before surgery.
- For those on insulin pump therapy (with or without a closed loop system), continue pump as usual until the time of surgery.

Morning of surgery

- Light breakfast at 07.00h on the morning of the procedure and then starve (check with anaesthetists for exact timing).
- For those on **multiple daily injection (MDI)** regimen, rapid-acting insulin should be taken at the FULL usual dose according to carbohydrate content as well as usual correction dose depending on pre-meal BG level. Basal insulin (e.g. Glargine, Levemir or Tresiba) if given in the morning, should also be given in FULL.
- Start IV fluids at maintenance rate and IV insulin according to sliding scale at 12.00h noon aiming to keep BG level between 5.0 and 11.1 mmol/l (see appendix).
- Measure BG hourly pre-theatre and half-hourly during surgery.
- Patients on **insulin pumps (with or without a closed loop system)** should continue their background insulin until IV fluids and insulin are started at which point the pump should be switched off.

Post-operatively

- Measure BG and ketones hourly.
- Continue IV fluids and IV insulin until taking adequate oral fluids and snacks then change back to subcutaneous insulin (see appendix).
- Always give basal insulin analogue (subcutaneous insulin glargine or levemir) at usual time, even if still on IV fluids and insulin sliding scale.

Minor Elective Surgery (Morning list)

- Liase with the diabetes team well before the date of surgery.
- To be seen by a member of the diabetes team 2-3 weeks ahead to discuss control and pre- and post- operative management with child and parents.
- Normal insulin and diet the day before surgery.
- Admit on the morning of the surgery.

Pre-operatively

- Child should be first on the list ideally.
- IV cannula to be inserted on admission to the ward.
- No IV fluids or insulin needed unless high or low BGs.
- Food or formula milk can be given 6 hours before theatre, breast milk 4 hours before theatre and clear fluids up to 2 hours before theatre.
- Measure and record the capillary BG hourly pre-operatively and half hourly during the operation.

If on **multiple daily injection (MDI)** regimen and BG stable between 5-11.1mmol/l:

- omit rapid acting insulin (e.g. insulin aspart (NovoRapid), insulin lispro (Humalog), glulisine (Apidra)) in the morning until after the procedure when they can have it with a late breakfast.
- if basal insulin analogue (Glargine, Levemir or Tresiba) is usually given in the morning continue to give it as usual.

If on insulin pump therapy or using pump as part of hybrid closed loop system:

- prior to surgery run the pump at the usual basal rate and check the BG hourly asking parents to adjust the basal rate to maintain the BG between 5.0-11.1mmol/l (if using closed loop system, ask parents to come out of automode into manual mode).
- run the pump at the normal basal setting for the duration of the procedure ensuring the subcutaneous infusion cannula is secured to prevent dislodgement and interruption of insulin delivery.
- BG should be checked hourly once nil by mouth and half hourly during the operation. The 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 they have no basal insulin in their body.

However, for all insulin regimes, if:

- BG <5mmol/l give a bolus of IV 10% glucose at a dose of 2 ml/kg and recheck the BG 15 minutes later to ensure it is \geq 5mmol/l.
- BG >12mmol/l start IV insulin infusion and IV fluids as per sliding scale.
- the procedure is delayed for a further 2 hours or child has repeated low BG's, start on maintenance IV fluids.

Post-operatively

- Measure the BG hourly for four hours.
- Can eat and drink when conscious, to give usual rapid acting insulin with that meal.
- Patients using an insulin pump (with or without a closed loop system) can re-start the pump at the usual basal rate once the child has recovered.
- If not tolerating fluids then to stay overnight and continue infusion till next morning.
- Discharge home once eating and drinking. Advise parents to phone the ward for advice if worried in the night.
- Normal subcutaneous insulin the next day.

Minor Elective Surgery (Afternoon list)

- Liaise with the diabetes team well before the date of surgery.
- To be seen by a member of the diabetes team 2-3 weeks ahead to discuss control and pre- and post-operative management with child and parents.
- Advise usual doses of insulin the night before the procedure.
- Advise the child to have a normal breakfast no later than 7.30 a.m.
- Patient to have breakfast insulin dose dependent on regimen.

If on a multiple daily injection (MDI) regimen:

- give FULL usual dose of rapid-acting insulin (e.g. insulin aspart (NovoRapid), Humalog lispro (Humalog), glulisine (Apidra)) according to carbohydrate content of breakfast as well as usual correction dose depending on pre-meal BG level (BG).

- Glargine (Lantus) or Detemir (Levemir) or Degludec (Tresiba) if given in the morning should also be given in FULL.

If on insulin pump therapy or using pump as part of hybrid closed loop system:

- run the pump on the normal basal setting.
- BG should be checked at least hourly. Carer/patient asked to alter infusion rate accordingly to maintain BG between 5-11.1 mmol/l.

Pre-operatively

- Measure and record capillary BG on arrival.
- Insert IV cannula.
- Child should be first on the list.
- Food or formula milk can be given up to 6 hours before theatre, breast milk up to 4 hours before theatre and clear fluids up to 2 hours before theatre.
- 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, **for all insulin regimes**, if:

- BG <5mmol/l give a bolus of IV 10% glucose at a dose of 2 ml/kg and recheck the BG 15 minutes later to ensure it is \geq 5mmol/l.
- BG >12mmol/l start IV insulin infusion and IV fluids as per sliding scale.
- the procedure is delayed for a further 2 hours or child has repeated low BGs, start on maintenance IV fluids.

If on insulin pump therapy or using pump as part of hybrid closed loop system:

- should continue their pump as long as their BG remains between 5.0-11.1mmol/l ensuring the subcutaneous infusion cannula is secured to prevent dislodgement and interruption of insulin delivery.
- BG should be checked hourly pre-operatively and half-hourly during surgery
- if BG <5mmol/l suspend the pump for 30 minutes as well as giving a 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 they have no basal insulin in their body.

Post-operatively

- Measure the BG hourly for four hours.
- Can eat and drink when conscious. Once eating, give usual dose rapid acting insulin generally taken with that meal.
- If not tolerating fluids then to stay overnight and continue infusion till next morning.
- If needing IV fluids and insulin infusion, change back to subcutaneous insulin (see appendix).
- For those on an insulin pump regimen (with or without a closed loop system), allow parents to re-start the pump at the usual basal rate once the child has recovered. Discharge when the child is eating and drinking, regardless of BG level; parent will control better at home.
- Discharge home once eating and drinking. Advise parents to phone the ward for advice if worried in the night.
- Normal subcutaneous insulin the next day.

MRI scan under GA

- Remove any insulin pumps, metal canulae and continuing glucose monitoring devices – e.g. Dexcom/Guardian/Libre/ Libre 2, prior to entering MRI scanner.

- MRI Scan must be interrupted as necessary to enable a blood glucose sample to be obtained every 30 minutes. The blood glucose testing equipment will need to be remain outside the scan room.

Multiple daily injections (MDI/Basal bolus) regimen:

- If scan expected to be < 2 hours follow guidance as per minor elective surgery depending on timing of MRI.
- If expected to be longer than 2 hours follow guidance as per major elective surgery depending on timing of MRI.

Insulin pump (with or without hybrid closed loop system):

- If scan expected to be < 1 hour follow guidance as per minor elective surgery depending on timing of MRI BUT remove insulin pump/metal canulae AND any CGM (if using).
- The insulin pump can safely be removed for up to 1 hour if BG levels are in target 5-11.1 mmol/l. Provision must be made to enable reinsertion of insulin pump after 1 hour. If insulin pump cannot be reinstated after 1 hour from when it was discontinued then IV fluids and insulin should be commenced as they have NO basal insulin in their body.
- If scan expected to be > 1 hour follow guidance as per major elective surgery depending on timing of MRI BUT remove insulin pump/ metal canulae AND any CGM (if using).

After MRI:

- Replace insulin pump and/or continuing monitoring device (if used) post MRI.
- For children on insulin pump therapy a correction bolus may be required if blood glucose is above target on reinsertion of the insulin pump. The parent/carer can deliver this as per their usual practice.
- If BG is 14mmol or more on pump re-insertion sick day rules should be followed.

APPENDIX

Maintenance fluid guide

- Fluid of choice – 0.9% saline / 5% glucose.
- Use 5 % glucose, however if there is concern about hypoglycaemia use 10% glucose. If BG is high (>12mmol/l) increase insulin supply.
- Monitor electrolytes, but always include 20 mmol/l potassium chloride (KCL) in intravenous fluid.

Maintenance fluid calculation

	Body weight in kg	Fluid requirements in 24 hours
For each kg between	3-10kg	100ml/kg
For each kg between	11-20kg	Add an additional 50ml/kg
For each kg over	Over 20kg	Add an additional 20ml/kg

Insulin infusion guide

- Dilute 50 units soluble insulin (Actrapid) in 49.5 ml 0.9% saline; this gives 1 unit per ml.
- Start infusion at:
 - 0.025 ml/kg/h (i.e., 0.025 U/kg/hour) if BG is between 6–8mmol/l,
 - 0.05 ml/kg/h if 8–12mmol/l,
 - 0.075 ml/kg/h between 12–15mmol/l

- 0.1 U/kg/h 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:
 - BG > 20mmol/l - contact Diabetes team
 - BG > 15mmol/l - increase rate by 25%
 - BG < 8mmol/l - decrease rate by 50%
 - BG < 5mmol/l - stop the IV insulin infusion but only for 10–15 min. Give bolus of IV 10% glucose at a dose of 2 ml/kg, recheck BG 15 minutes later to ensure BG >5mmol/l.

How to restart subcutaneous insulin after being on intravenous insulin

If ready to eat at **lunch** give the following insulin:

- For those patients on a **multiple daily injection** regimen using a long acting basal insulin analogue e.g. Tresiba, give rapid acting insulin with lunch. Check that long-acting insulin has been carried on throughout the stay. If they have missed a dose, delay re-starting subcutaneous insulin until they have had the long-acting insulin.
- For those patients on **insulin pump therapy (with or without a hybrid closed loop system)** the parents can 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 **evening meal** give the following insulin:

- For those patients on a **multiple daily injection** regimen with a long-acting basal insulin analogue e.g. Tresiba, give rapid acting insulin with the evening meal and long-acting insulin analogue at the usual time.
- Always give the dose of long-acting basal insulin analogue e.g. Tresiba at the usual time even if still on intravenous fluids and intravenous insulin overnight to prevent rebound hyperglycaemia.
- Stop IV insulin 10 minutes after subcutaneous insulin has started if the child is given a rapid acting insulin dose
- For those patients on **insulin pump therapy (with or without a hybrid closed loop system)** the parents can 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. Stop IV insulin and fluids 10 minutes after subcutaneous insulin has started. Parents should be allowed to manage according to their usual practice

Guideline for children on oral medications

Metformin:

- Discontinue at least 24 hours before procedure for elective surgery and for 48 hours after surgery.
- In emergency surgery and when metformin is stopped < 24 hours beforehand, ensure optimal hydration before, during and after surgery to prevent lactic acidosis; risk is increased with renal insufficiency. 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

1. Agwu JC, Ng M, Edge JA, Drew JH, Moudiotis C, Wright NP, Kershaw M, Trevelyan N, Goonetilleke R. (2013) *ACDC Clinical Guideline: Care of children under 18 years with Diabetes Mellitus undergoing surgery.*
2. Rhodes ET, Gong C, Edge JA, Wolfsdorf JI, Hanas R. (2014) *Management of children with diabetes requiring surgery.* Pediatric Diabetes 2014; 15(Suppl. 20): 224-231.
3. Dronge AS, Perkal M F, Kancir S, Concato J, Aslan M, Rosenthal RA. (2006) *Long-term glycemic control and postoperative infectious complications.* Arch Surg 141, 375-380