

FASTING AND SURGERY- TYPE 1 DIABETES MELLITUS (T1DM)- CHW

PRACTICE GUIDELINE[®]

DOCUMENT SUMMARY/KEY POINTS

- This practice guideline is intended primarily for use in the tertiary Paediatric environment of The Children's Hospital at Westmead. However, it can be applied for minor procedures and surgery in other settings according to the judgement and supervision of the treating medical team (anaesthetist, surgeon, others). Except in emergencies, major surgery should be performed in a tertiary paediatric surgery whenever possible.
- The Diabetes team (via the on-call service) is available to assist with advice to treating medical staff related to this protocol, however does not have authority to directly manage patients outside of The Children's Hospital at Westmead.
- Pre-surgical assessment should be done by anaesthetists as standard practice in the days/weeks leading up to elective surgery. This is to allow for an assessment of glycaemic control, electrolyte status, ketones (urine or blood) and to plan the insulin and fluid regimen for surgery and liaison with the endocrine team if necessary.
- Schedule operations early in the morning if possible. If not possible, schedule first on the afternoon list. This allows postoperative stabilisation during the day.
- Some insulin is needed, even when fasting, to avoid ketoacidosis.
- Specific adjustment of insulin doses and schedule is required depending on the type of surgery (major or minor) and the time of the surgical procedure.
- The optimal method of maintaining metabolic control during major surgery (surgical procedure lasting ≥ 2 hours) or prolonged fasting is by an insulin infusion. See [Appendix 1: Preparing, starting and adjusting an insulin infusion using Insulin Adjustment Algorithm](#)
- Blood glucose monitoring is generally required hourly once fasting commences (i.e. the time of the first missed meal), and during and immediately after the surgical procedure. Aim for blood glucose levels between **5–10mmol/L**.
- If hypoglycaemia (blood glucose < 4 mmol/L) occurs while fasting and up to 2 hours before surgery, it may be treated orally with carbohydrate containing clear fluids (e.g. fruit juices (no-pulp) or carbohydrate rich drinks (CarbPlus)), as per [Hypoglycaemia Management in Type 1 Diabetes Nursing Management – CHW Practice Guideline](#).

Approved by:	SCHN Policy, Procedure and Guideline Committee	
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Team Leader:	Staff Specialist	Area/Dept: Endocrinology

- A patient on a basal/bolus insulin regimen (Lantus or Levemir as the basal insulin) or continuous subcutaneous insulin infusion (pump therapy) may initially receive an IV fluid infusion without glucose for minor surgery or procedures lasting less than 2 hours.
- An IV infusion with glucose is required for major surgery or procedures lasting ≥ 2 hours or if patient is treated with NPH insulin which peaks 4-12 hours after administration.

CHANGE SUMMARY

- Previous versions available on the CHW Endocrinology Department intranet page have been removed and replaced by this version.

READ ACKNOWLEDGEMENT

- Clinicians (medical and nursing) caring for diabetic patients who require surgery should read and acknowledge they understand the contents of this document.

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1 Insulin delivery in type 1 diabetes

Typically, insulin is delivered in one of three ways.

1.1 Insulin pumps (CSII)

Continuous subcutaneous insulin infusion (CSII) pumps deliver rapid acting insulin continuously at pre-programmed basal rates (expressed in units of insulin per hour). Boluses of insulin are delivered before meals and to correct hyperglycaemia.

1.2 Basal-bolus insulin regimen with Lantus[®] or Levemir[®]

- Basal insulin is long-acting insulin (Lantus or Levemir) and is given subcutaneously in the evening or morning.
- Boluses of short or rapid-acting insulin are given before each meal.

1.3 Other regimens with intermediate/isophane/NPH or premixed/biphasic insulin

- This method of insulin delivery is not routinely used in current practice. Please consult the on-call endocrine team well in advance to discuss the insulin adjustment prior to surgery.
- Examples of intermediate or biphasic insulin include: Humulin NPH[®], Protaphane[®], Hypurin Isophane[®], Humulin 30/70[®], Mixtard 30/70[®] or Mixtard 50/50[®], NovoMix 30, Humalog Mix25, Humalog Mix50.

2 Pre-operative assessment of children with diabetes

Pre-operative assessment should be performed by the anaesthetists as a standard process in a Pre-operative Clinic prior to elective surgery. This assessment should include:

- Assessment of recent BGL control and consider measuring HbA1c if a recent measure is not available.
- Review of the child's total daily insulin requirements and record the insulin regimen and doses.
- Review of insulin pump data. If the patient is on an insulin pump check the average total daily insulin dose delivered in the last 7 days and the percentage of basal and bolus insulin. Basal insulin should be approximately 40-50% of total daily dose. Check and record the insulin sensitivity factor (ISF) and insulin to carbohydrate ratio (ICR).
- If control is uncertain or poor, liaise with endocrinology team and consider admission 1–3 days beforehand for assessment and stabilisation.

- Consider postponing elective surgery if HbA1c is >10%, Elective surgery should only be performed if diabetes is under good control.
- If glycaemic control is good and everything else is straightforward, liaison with endocrinology team may not be routinely required if this guideline is followed.

3 Peri-operative fasting: general approach

3.1 Safe Fasting Times

	Hours
Clear Fluids* all children should be encouraged to drink clear fluids up to 2hrs pre-op	2
Breast milk (ask about normal feeding patterns)	4
Infant formula (ask about normal feeding patterns)	6
Non-human milk (ask about normal feeding patterns)	6
Solids and gastric tube feeds (including lollies and chewing gum)	#6
Transpyloric tube feeds (treated as clear fluids if tube position is confirmed)	2

* Clear fluids are liquids you can see through, e.g. water, clear fruit juices (no-pulp), tea, or black coffee (no milk), clear sports drinks (but not red or purple), carbohydrate rich drinks (CarbPlus) but no solid or milk-based beverages such as cappuccino or milk shakes.

Whilst patients will be instructed not to suck on lollies or chew gum after they are told to stop eating solids they should not have their operation cancelled or delayed just because they are chewing gum or sucking a boiled sweet immediately prior to induction of anaesthesia (ESA Guidelines).

- Patients on insulin should be scheduled as the first case on the morning list when possible. If not possible, schedule first on the afternoon list. This minimises fasting times and allows postoperative stabilisation during the day.
- BGL monitoring should commence from the time of fasting (i.e. the time of the first missed meal). Blood glucose monitoring is generally required hourly. Aim to maintain blood glucose levels of 5–10mmol/L.

3.2 Managing inadvertent hypoglycaemia

If hypoglycaemia (blood glucose < 4mmol/L) occurs while fasting and **more than 2 hours** before the start of anaesthesia, it may be treated orally with carbohydrate containing clear fluids as per [Hypoglycaemia Management in Type 1 Diabetes Nursing Management – CHW Practice Guideline](#).

Pre-operatively (≥2 hours before anaesthesia)

- **3-12mths (not for neonates)**
 - Give 15mL of CarbPlus solution (from formula room) or 60-100mL of apple juice (or clear fruit juice: no pulp) when CarbPlus is not available or unpalatable.
 - Consider giving infant a breastfeed or bottle depending upon fasting time (see Table 2.1 Safe Fasting Times)
 - Retest BGL in 15 -20 minutes. If child remains hypoglycaemic repeat treatment and call Endocrine team as IV fluids containing Glucose will need to be commenced, usually 0.9% sodium chloride + 5% glucose.
- **1yr and older**
 - Give 125-200mL of clear fruit juice (no pulp)
 - Retest the BGL in 15 – 20minutes. If child remains hypoglycaemic repeat treatment and call Endocrine team as IV fluids containing Glucose will need to be commenced, usually 0.9% sodium chloride + 5% glucose.

Pre-operatively (< 2 hours before anaesthesia)

- If hypoglycaemia (blood glucose < 4mmol/L) occurs within 2 hours of starting general anaesthesia, notify the anaesthetic team immediately.
- Place an IVC to give 2mL/kg of 10% glucose as a bolus followed by maintenance IV fluids containing 5% glucose.
- Surgery may need to be postponed until later on the list if no IVC is in situ and if hypoglycaemia needs to be treated orally to prevent delay in treatment of hypoglycaemia.

Intra-operatively

- Measure BGL at least hourly.
- For those on intravenous insulin infusion use the algorithm for hourly insulin adjustment taking into account ambient BGL and change over the last hour (in response to previous change in infusion rate). See [Appendix 1: Preparing, starting and adjusting an insulin infusion using Insulin Adjustment Algorithm](#)
- If patient is not on an intravenous insulin infusion i.e. on subcutaneous insulin injections or an insulin pump follow below:
 - If BGL less than < 5 mmol/L, commence 5% glucose, or if already on 5% glucose then increase the rate or glucose concentration of the infusion in increments of 2.5% glucose.
 - If the BGL is < 4 mmol/L administer an initial 2mL/kg bolus of 10% glucose.

- Measure the BGL after 15 minutes and adjust glucose infusion to 7.5% or 10% as necessary to maintain the BGL >5 mmol/L.

4 Peri-operative care for children with diabetes on insulin

4.1 Minor surgery (i.e. procedure which lasts less than 2 hours)

- Schedule procedure for 8am, check 6am BGL.
- Start maintenance IV fluids with 0.9% sodium chloride + 5% glucose at 6 am if BGL<5mmol/L, otherwise intravenous fluids are not required preoperatively.
- Monitor blood glucose level hourly.
- If there is any delay in the operating theatre or in establishing oral intake following the procedure, consider starting IV 5% glucose +/- an insulin infusion and contact the endocrine team if further advice is required.
- Specific adjustment of the insulin schedule will depend upon the type of surgery (minor or major), the time of the procedure (morning or afternoon) and the patient's usual insulin regimen, the three most common regimens being:
 - Patients on continuous subcutaneous insulin infusion (pump therapy).
 - Patients on basal-bolus regimen with Lantus or Levemir.
 - Patients on regimens containing intermediate/isophane/NPH or premixed insulin.

4.1.1 *Patients on continuous subcutaneous insulin infusion (pump therapy)*

- Continuous subcutaneous insulin infusion should be continued during the surgical procedure when possible.
- Change and secure the subcutaneous insulin infusion cannula away from the surgical site the night before the surgery.
- Continue the basal insulin infusion rate via the insulin pump as usual.
- Check BGL hourly once the patient is nil by mouth, during the procedure and post operatively until oral intake resumes.
- Insert IV cannula and consider starting IV fluids depending upon fasting time etc. Patients with a blood glucose level >5mmol/L may initially have IV fluids without glucose.
- Use IV fluid of 0.9% sodium chloride + 5% glucose if BGL<5mmol/L.
- Basal insulin can be temporarily suspended, if necessary for no more than 30 minutes to assist correction of hypoglycaemia but does not replace need for glucose administration if hypoglycemic.

- Consider setting a temporary basal rate (e.g. 80% of usual basal rate) if surgery is delayed or food is not tolerated post operatively or BGLs are below 5mmol/L.
- Postoperatively, stop IV fluids once oral intake resumes. Give bolus doses of insulin via the insulin pump when the patient starts eating after the procedure.

4.1.2 Patients on basal-bolus insulin with Lantus or Levemir

Procedure first on morning list

- Consider the need for reduction (20–30%) of evening basal (long acting) insulin if there is a pattern of low blood glucose levels (BGL) in the mornings.
- If basal (long acting) insulin is usually given in the morning, give the usual dose.
- Omit the morning dose of short or rapid-acting insulin.
- Check BGL hourly once the patient is nil by mouth, during the procedure and post operatively until oral intake resumes.
- Insert IV cannula and consider starting IV fluids depending upon fasting time etc. Patients with a blood glucose level >5mmol/L may initially receive IV fluids without glucose.
- Use IV fluid of 0.9% sodium chloride + 5% glucose if BGL<5mmol/L.
- Postoperatively, give additional rapid-acting insulin, usually 5-10% of total daily dose as needed 2-4-hourly if BGL>10mmol/L. Alternatively, if the patient has a known and documented Insulin Sensitivity Factor (ISF), the correction dose of insulin can be calculated using this. The ISF is the expected reduction in blood glucose (mmol/L) that 1 unit of rapid-acting insulin is expected to cause.
- Usually can resume normal food and insulin from lunchtime.

Procedure first on afternoon list

- Give the usual dose of morning or evening basal (long acting) insulin.
- The patient is usually allowed breakfast.
- At approximately 7am give the usual dose of rapid-acting insulin with breakfast. If the patient has short acting insulin with breakfast, give 60% of the usual short acting insulin with breakfast.
- Start IV fluids 0.9% sodium chloride + 5% glucose at maintenance fluid rates, 2 hours before surgery. Increase glucose to 7.5% or 10% if required.
- Check BGL hourly once the patient is nil by mouth, during the procedure and post operatively until oral intake resumes.
- Postoperatively, give additional rapid-acting insulin, usually 5-10% of total daily dose as needed 2-4-hourly if BGL>10mmol/L. Alternatively, if the patient has a known and documented Insulin Sensitivity Factor (ISF), the correction dose of insulin can

be calculated using this. The ISF is the expected reduction in blood glucose (mmol/L) that 1 unit of rapid-acting insulin is expected to cause.

- Usually can resume normal food and insulin at dinner or supper time.

4.1.3 Patients on regimens containing intermediate/isophane/NPH or premixed insulin

- Contact the endocrine team well in advance to discuss insulin adjustment for the day of surgery.
- Admission the day before surgery may be required.
- Options for insulin adjustment include:
 - Changing to basal-bolus regimen for the peri operative period.
 - If first on the morning list, give 50% of the usual morning intermediate acting insulin and withhold the usual morning short/rapid acting insulin until after the procedure.
 - If first on the afternoon list, give 50% of the usual morning intermediate acting insulin. Given rapid acting insulin to cover for breakfast if breakfast is permitted
- Depending on the insulin adjustment regimen chosen, consider starting IV fluids 0.9% sodium chloride + 5% glucose at maintenance fluid rates, 2 hours before surgery. Increase glucose concentration to 7.5% or 10% if required.
- Check BGL hourly once the patient is nil by mouth, during the procedure and post operatively until oral intake resumes.
- Postoperatively, stop IV fluids once oral intake resumes.
- Postoperatively, give additional rapid-acting insulin, usually 5-10% of total daily dose as needed 2-4-hourly if BGL>10mmol/L.
- The usual dose of evening insulin can be given if the patient has recovered and is eating normally, otherwise a reduced dose will be needed.

4.2 Major surgery (i.e. procedure which lasts more than 2 hours)

The optimal method of maintaining metabolic control during major surgery or prolonged fasting is by an intravenous insulin infusion with hourly blood glucose levels.

Optimally the insulin infusion should start at least 2 hours prior to surgery to establish the rate of insulin infusion required to stabilise the blood glucose levels.

See [Appendix 1: Preparing, starting and adjusting an insulin infusion using Insulin Adjustment Algorithm](#)

4.3 Emergency Surgery

Although most surgical procedures are elective, both minor and major procedures may occur as emergencies. It is important to remember that acute illness can precipitate DKA and that DKA can present as an acute abdomen.

- Before emergency surgery always check BGL and blood or urinary ketones. If ketones are elevated check EUC and blood gas.
- Monitor BGLs regularly.
- Allow clear fluids with added glucose up until 2 hours pre-operatively unless nil by mouth status assigned by the treating surgical team.
- Contact on-call endocrine team for further advice on insulin adjustment.

5 Post-Operative Management

- Measure BGL hourly until the patient is eating or drinking.
- If the patient is expected to be able to eat and drink soon after their operation, then once this occurs their usual insulin management can be recommenced.

6 Fasting unrelated to surgical procedure in patients with type 1 diabetes

- Some T1DM patients have prolonged periods of fasting unrelated to surgery. E.g. for diagnostic imaging, gut rest etc., and this protocol can be used for such patients.
- Shorter periods of fasting can be dealt with by adjustments of sub cutaneous insulin or pump regimen as described above. For more prolonged fasting, an intravenous insulin infusion with hourly BGLs is a reliable method of controlling BGL.
- To set up an insulin infusion refer to [Appendix 1: Preparing, starting and adjusting an insulin infusion using Insulin Adjustment Algorithm](#)

7 References

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Appendix 1: Preparing, starting and adjusting an insulin infusion using Insulin Adjustment Algorithm

Preparing an insulin infusion in PICU

- In PICU due to the availability of syringe pump drivers with programmable smart pump technology a syringe containing an insulin concentration of **1unit/mL** may be prepared.
- To prepare 1unit/mL syringe for use in a programmable smart pump in PICU only:
 - Draw up 50 units of (Actrapid or Humulin R) in an insulin syringe (calibrated in units) and add to sodium chloride 0.9% to give a final volume of 50 mL (giving a solution of 1 unit insulin in 1mL). Mix well by inverting the syringe several times.
 - Prime the connecting tubing by running some of the infusion into a kidney dish (usually 5mL is used to prime the line since insulin also adsorbs to plastic).

Preparing an insulin infusion in the Wards and Emergency Department

- Due to the unavailability of syringe pump drivers with programmable smart pump technology on most ward areas and in ED, a bag containing an insulin concentration of **0.1unit/mL** is used.
- To prepare 0.1unit/mL bag for use in wards and ED:
 - Add 100 units of insulin (Actrapid or Humulin R) to 1000mL of sodium chloride 0.9%.
 - Mix well by inverting the bag several times.
 - Prime the connecting tubing by running some of the infusion into a kidney dish.

Starting insulin dose and adjusting the insulin infusion

- The initial insulin infusion rate is 0.02-0.03 units/kg/hr. The starting dose will be specified by the Endocrine team. The insulin infusion can be run through the same line as the IV glucose containing fluids.
- If BGL is >15mmol/L at initiation of insulin infusion consider starting at higher dose of up to 0.06units/kg/hr.
- Administer IV fluids containing 5% glucose at maintenance rate.
- Perform hourly BGLs while on an insulin infusion.
- Maintain blood glucose level (BGL) between 5 and 10mmol/L by adjusting the rate of the insulin infusion up or down by increments of 10–30%, as needed, using the “Perioperative IV Insulin Infusion Adjustment Algorithm” below.
- If the patient is hypoglycaemic (BGL between 3-4mmol/L), temporarily cease the insulin infusion for 30 minutes, then recheck BGL and resume insulin infusion at a 40% lower rate when the BGL is >5mmol/L while continuing maintenance IV maintenance fluids containing glucose (IV insulin has a half-life of only 3 to 4 minutes).
- If the patient is severely hypoglycaemic (BGL <3mmol/L or symptomatic), temporarily cease the insulin infusion and urgently give a bolus of 2mL/kg of 10% glucose or equivalent. Recheck BGL in 15 minutes and resume insulin infusion at a 40% lower rate when the BGL is >5mmol/L.
- Do not stop the insulin infusion if blood glucose 4-5mmol/L as this will cause rebound hyperglycemia. Reduce the rate of infusion instead.
- Give replacement potassium if the patients continues IV fluids and is nil by mouth for more than 12 hours.
- The intravenous insulin infusion with IV fluids containing glucose is continued until oral food intake has been established and subcutaneous insulin therapy is possible. When changing to subcutaneous insulin as per Endocrine team, continue the intravenous insulin infusion for 90 minutes after the first subcutaneous insulin injection.

Appendix 1: Peri-operative IV Insulin infusion – Adjustment Algorithm

(E.g. if a 20kg child is on a starting rate of 0.02 Units/kg/hr, this equals 0.4 Units/hr = 0.4mL per hour if using 1unit/mL solution in PICU, or 4mL per hour if using 0.1unit/mL in ED or on the wards)

The table indicates the change in insulin infusion rate from the current hourly rate according to the current BGL and rate of change of BGL in the previous hour.

Current BGL (mmol/L)	Change in BGL from last hour						
	No change (within 1.0mmol/L of last hours BGL)	Falling slowly Fall of 1.1 – 2 mmol/L/hr	Falling moderately Fall of 2.1-4 mmol/L/hr	Falling quickly Fall of > 4mmol/L/hr	Rising slowly Rise of 0.6 – 2 mmol/L/hr	Rising moderately Rise of 2 – 4 mmol/L/hr	Rising quickly Rise of > 4mmol/L/hr
> 15mmol/L	Increase by 10%	Increase by 10%	No change	Decrease by 20%	Increase by 20%	Increase by 20%	Increase by 20%
12.1 –15mmol/L	Increase by 10%	Increase by 10%	Decrease by 10%*	Decrease by 20%*	Increase by 20%	Increase by 20%	Increase by 20%
8.1 – 12mmol/L	Increase by 10%	No change	Decrease by 20%*	Decrease by 30%*	Increase by 10%	Increase by 20%	Increase by 20%
5.1 – 8mmol/L	No change	Decrease by 10%	Decrease by 20%*	Decrease by 50%*	No change	No change	Increase by 20%
4.1 – 5mmol/L	Decrease by 10%	Decrease by 20%	Decrease by 30%*	Decrease by 50%*	No change	No change	No change
3.1 – 4mmol/L	<ul style="list-style-type: none"> Cease temporarily. Recheck BGL in 30 mins & when BGL >5mmol/L recommence infusion at 40% lower than the previous rate. 						
≤ 3mmol/L	<ul style="list-style-type: none"> Cease infusion Give IV glucose bolus 2mL/kg of 10% Glucose. Recheck BGL in 15 mins & when BGL >5mmol/L recommence infusion at 40% lower than the previous rate 						

*Recheck BGL in 30 minutes