

TYPE 1 DIABETES MELLITUS IN CHILDREN DURING SURGERY AND FASTING - SCH

PRACTICE GUIDELINE[®]

DOCUMENT SUMMARY/KEY POINTS

- Schedule the procedure to be first on the list in the morning.
- Some insulin is needed, even when fasting, to avoid ketoacidosis.
- Intravenous glucose may be needed when fasting to avoid hypoglycaemia.
- Consider admission to hospital the preceding day, especially if IV insulin infusion will be needed for the procedure.
- Endocrine team to discuss modifying insulin doses with all families in the week prior to admission to avoid hypoglycaemia

This document reflects what is currently regarded as safe practice. However, as in any clinical situation, there may be factors which cannot be covered by a single set of guidelines. This document does not replace the need for the application of clinical judgement to each individual presentation.

Approved by:	SCHN Policy, Procedure and Guideline Committee	
Date Effective:	1 st November 2021	Review Period: 3 years
Team Leader:	Head of Department	Area/Dept: SCH Endocrinology

CHANGE SUMMARY

- Change of document title to include the word diabetes to allow easy search.
Previous title: Diabetic Children: Surgery and Fasting – SCH (2013-7048 v2)
- Addition of advice for management of continuous subcutaneous insulin infusion (CSII or Insulin Pump) and Continuous Glucose Monitoring (CGM) during fasting and surgery.
- More detailed advice provided for pre-admission diabetes management as many patients will be admitted on the day of surgery

READ ACKNOWLEDGEMENT

- All Clinical nurses and medical officers must read and acknowledge they understand the contents of this document.
- Mandatory annual BLS accreditation must be maintained.
- Line managers are to maintain records of staff read acknowledgements for quality review and compliance audit processes.

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1 Principles

1. Schedule the procedure to be first on the list in the morning.
2. Some insulin is needed, even when fasting, to avoid ketoacidosis.
3. Intravenous glucose may be needed when fasting to avoid hypoglycaemia.
4. Consider admission to hospital 1-3 days beforehand for assessment and stabilisation if diabetes control is poor or unknown, major procedure or significant co-morbidities.

2 Before booking the procedure

1. Review diabetes control. If diabetes control is poor (e.g. HbA1c > 9.5%), review diabetes management and compliance. Consider deferring elective procedures until control improved.
2. Schedule the procedure to be first on the list, preferably in the morning.
3. Decide which of the following plans should be used:
 - A. modified subcutaneous insulin injections (for procedures <2 hours)
 - B. For those on continuous subcutaneous insulin infusion (CSII, or insulin pump), continuation of insulin pump with or without modified basal rates (for procedures <2 hours)
 - C. intravenous insulin infusion
4. If the patient is to be admitted the day of surgery, the family must be contacted (by the endocrinology team) in the week prior to the procedure to advise on changes to regular insulin doses, glucose monitoring and fasting for the 24 hours prior to surgery. Recommendations will depend on the patient's usual insulin regimen, current diabetes control and glucose trends, the type of surgery (minor or major, elective or emergency) and the time of the procedure (morning or afternoon).
5. Subcutaneous insulin regimens include:
 - a. Continuous Subcutaneous Insulin Infusion (CSII or pump therapy).
 - b. basal-bolus regimen with insulin glargine (Optisulin®) or insulin detemir (Levemir®)
 - c. regimens containing intermediate/isophane/NPH (Humulin®) or premixed insulin (uncommon)

3 Peri-operative management

3.1 Preoperative fasting and prevention of hypoglycaemia

(BGL <4 mmol/L):

- If admitted the day before, perform finger-stick blood glucose monitoring or observe CGM readings before meals, snacks, bedtime and 2-3am, as guided by Endocrine team.
- Hourly BGL monitoring should commence from the time of fasting (usually 6am). Aim to maintain BGL between 5-10 mmol/L.
- If hypoglycaemia (BGL <4 mmol/L) occurs whilst fasting AND is more than 1 hour before the start of anaesthesia it may be treated orally with clear glucose-containing clear fluids. E.g. clear apple juice (3 mL/kg to a maximum of 150 mL). Consider giving infants a breast feed or bottle depending on the fasting time.
- Recheck BGL in 15-20 minutes. If child remains hypoglycaemic, repeat treatment and call Endocrine team as glucose-containing IV fluids will need to be commenced (usually 0.9% sodium chloride and 5% glucose at maintenance rates).
- If hypoglycaemia occurs while nil by mouth, site IV and give 2 mL/kg of 10% glucose as bolus and start maintenance IV fluids 0.9% sodium chloride + 5% glucose. If IV cannula cannot be sited within a timely fashion give oral management as above, and advise anaesthetist of need to delay/postpone surgery.
- If the child is too drowsy to drink and there is no IV access, give glucagon subcut or IM
 - <25 kg : 0.5mL (= 0.5 mg)
 - >25 kg: 1 mL (=1 mg)
- 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.

A. Protocol: Modified Insulin Injections for Short Procedures Only

For short procedures (*under 2 hours*) where rapid recovery is anticipated:

- For procedures first on the morning list
 - Consider the need for reduction (by 20–30%) of evening basal (long-acting) insulin especially 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, or consider the need for reduction (by 20-30%) if at risk of hypoglycaemia.
 - Omit the morning dose of short or rapid-acting insulin.
 - If on a regimen containing intermediate/isophane/NPH or premixed insulin an individualised plan will need to be made after discussion with Endocrine Team.

- Check BGL hourly once the patient is nil by mouth, during the procedure and post operatively until oral intake resumes.
- Manage hypoglycaemia as per guidelines above.
- Recommence regular short acting insulin with first meal after waking.
- For procedures first on the afternoon list
 - Patients should receive their usual insulin the evening prior to fasting.
 - Patients should be given their usual basal (long-acting) insulin in the morning, considering a need for reduction (by 20-30%) to prevent hypoglycaemia.
 - The patient is usually allowed breakfast. If the patient is on an ultra-short acting insulin (e.g. Novorapid®, Humalog®, Fiasp®) give the usual insulin, and consider a need for reduction (by 20-30%) to prevent hypoglycaemia.
 - If patient is on Actrapid® at breakfast, discuss with Endocrine team and consider changing to a reduced dose of Novorapid®/Humalog®.
 - If on a regimen containing intermediate/isophane/NPH or premixed insulin, an individualised plan will need to be made after discussion with Endocrine team.
 - Check BGL hourly once the patient is nil by mouth, during the procedure and post operatively until oral intake resumes.
 - Manage hypoglycaemia as per guidelines above.
 - Recommence regular short- and long-acting insulins once the patient is awake and eating.

B. Protocol with Continuation of Subcutaneous Insulin Pump Therapy (CSII)

- CSII should be continued during the surgical procedure when possible, noting insulin pumps cannot be worn for procedures that require exposure to magnetic fields (MRI) or radiation.
- Patient should change the infusion set on the morning of the day before surgery (to give time for BGL monitoring during that day to check that the new set is working well).
- When fasting starts, continue insulin administration using the patient's usual basal rates (already programmed into the pump).
- Monitor the blood glucose by finger-stick hourly from fasting (usually 6am), including the intra- and post-operative recovery periods, until oral intake is re-established. If BGL >15 mmol/L check for ketones and if ketones >0.6 mmol contact the Endocrine team for advice regarding extra insulin. This may include increasing the basal rate, a correction dose via the pump or a subcutaneous injection of insulin.
- If patient is hypoglycaemic (i.e. BGL < 4 mmol/L) manage as per above guideline for hypoglycaemia.

- Basal insulin can be temporarily suspended if necessary (for no more than 30 minutes) to assist correction of hypoglycaemia but glucose should be administered if BGL <4 mmol/L.
- Once the patient is able to eat or drink, discontinue IV fluids and the patient can recommence pre-meal insulin via the insulin pump (by entering amount of carbohydrate and BGL for correction).
- Continuous Glucose Monitoring devices must be removed prior to surgery. This will disable any automated features of an insulin pump (hybrid closed loop). For patients on both CGM and insulin pump therapy it is vital to review current pump settings as the pump will be operating in manual mode from the time CGM is removed. Please discuss with Endocrine team when CGM can be re-inserted and Automode or equivalent re-entered.

C. Standard Protocol with IV Insulin Infusion

- Intravenous insulin infusions should preferably be running for at least 2 hours prior to surgery to ensure stable BGL. For this reason, most patients should be admitted the night prior to allow commencement of insulin infusion and IV fluids from 6am.
- Review blood glucose records (log-book or CGM) and last HbA1c.
- Give the usual dose of short-acting insulin (Humalog®, NovoRapid®, Actrapid®, Humulin R®, Apidra® or Fiasp®) with dinner.
- Consider the need for reduction (by 20–30%) of evening basal insulin (Levemir®, Protaphane® or Humulin NPH®) if there is a pattern of low BGL in the mornings. This will reduce the risk of hypoglycaemia overnight while fasting.
- If the patient is on Insulin Glargine (Optisulin®/Lantus®) in the evening, which has 24-hour action, consult the Endocrine team in advance about changing this to insulin detemir (Levemir®) for the day before surgery.
- Insert IV cannula, cap and flush.
- Perform finger-stick blood glucose monitoring before meals, snacks and at midnight, 3am and 6am.
- Start maintenance IV fluid and insulin infusion at 6am.
 - i. Give maintenance IV fluids as 0.9% sodium chloride + 5% glucose. If needed for longer than 12 hours, add maintenance potassium chloride. If IV fluids are needed for longer than 24 hours, collect electrolytes (EUC).
 - ii. Run insulin infusion initially at 0.02 units/kg/hr using a 50 mL syringe pump
 - iii. Chart PRN drugs for management of severe hypoglycaemia if required:
 1. 10% glucose IV 2 mL/kg bolus and
 2. glucagon IM/Subcut <25 kg : 0.5 mL (= 0.5 mg) or >25 kg: 1 mL (=1 mg)

- Check BGL by finger-stick hourly while insulin infusion running.
- Aim to maintain BGL between 6 and 12 mmol/L by varying the insulin infusion rate each hour according to BGL (see table below as a guide). Contact the Endocrine team for advice if unsure.
- Continue the insulin infusion until tolerating oral intake of solid food, at which point:
 - i. If due for a subcutaneous insulin injection, give usual dose pre-meal and then stop the insulin infusion and IV glucose-containing maintenance fluid.
 - ii. If not due for an insulin injection, give short-acting insulin with meal (dose to be determined by Endocrine team) and stop insulin infusion and IV glucose-containing maintenance fluid.
 - iii. If the patient is usually on an insulin pump, recommence insulin pump and then stop the insulin infusion and IV glucose.

Preparation of Insulin Infusion:

- Use regular insulin, either Actrapid® (Novo Nordisk) or Humulin R® (Eli Lilly).
- Draw up the insulin using an insulin syringe (calibrated in units) and add to sodium chloride 0.9% to give final volume of 50 mL in a 50 mL syringe.
- If an insulin syringe is not available, note that Actrapid® and Humulin R® are available in a uniform concentration of 100 Units per mL. (e.g. 32 Units equates to 0.32 mL)
- Add the same number of units of insulin as the patient's weight in kg (e.g. if the patient weighs 32 kg, add 32 Units of insulin). **Running the infusion at 1 mL/hr will then deliver 0.02 Units/kg/hr.**
- Prime the connecting tubing by running some of the infusion into a kidney dish.

Important: Ensure that the insulin and glucose-containing infusions are going through the **same cannula (or central catheter)** to avoid any interruption to glucose-containing infusions while insulin is still running. (Note that insulin is compatible with TPN)

If Blood Glucose is:	Then, make the following change to insulin infusion rate:
> 12 mmol/L	<p>Increase insulin infusion by an increment of 0.1 mL/hr.</p> <p>With the next BGL, one hour later:</p> <ul style="list-style-type: none"> if BGL is still >12 mmol/L but is coming down, do not make a second increase (i.e. leave insulin infusion at the same increased rate) if BGL is still >12 mmol/L and is stable or increasing, make another increase of 0.1 mL/hr if BGL is between 7 and 12 mmol/L next hour, leave insulin infusion at the same increased rate.
7.1 - 12 mmol/L	Leave insulin infusion unchanged
5.1 - 7 mmol/L	Decrease by an increment of 0.1 mL/hr
4 - 5 mmol/L	Decrease by an increment of 0.1 mL/hr and double the rate of the maintenance glucose-containing fluid for 1 hour
<4 mmol/L	<p>Cease the insulin infusion for 30 minutes and double the rate of the maintenance glucose-containing fluid for 1 hour. Check the BGL again in 30 minutes.</p> <p>When BGL >5 mmol/L, restart the insulin infusion (but decrease the rate by an increment of 0.2 mL/hr).</p>
<2.5 mmol/L	<p>Cease the insulin infusion and give IV 10% glucose 2 mL/kg as a push dose and double the rate of the maintenance glucose containing fluid. Recheck BGL in 15-20 minutes. When BGL >5 mmol/L, reduce the IV fluids to maintenance rates and restart the insulin infusion (but decrease the rate by an increment of 0.2 mL/hr).</p>

D. 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 >1.6mmol, check EUC and blood gas.
- Monitor BGLs regularly.
- Allow clear fluids with added glucose until 1 hour pre-operatively unless nil by mouth status assigned by the treating surgical team.
- Contact on-call Endocrine team for further advice on insulin adjustment.

4 Patients wearing a Continuous Glucose Monitoring System

A continuous glucose monitoring system (CGM) is a small, self-inserted sensing device worn on the body. CGM transmits interstitial glucose levels to an insulin pump screen or receiver device (e.g. smartphone) about current sensor glucose status. Graphs and trend arrows show the direction of glucose values and rate of change, providing users with additional information to help their diabetes management. **It is important to note that the sensor measures the interstitial glucose level and not the blood glucose level.**

The guidelines for hospitalised patients are:

- 1. Sensor glucose values via CGM cannot be used for clinical decisions while an inpatient** (e.g. insulin administration, dose adjustment and hypoglycaemia management). In these instances, a blood glucose level is required (finger stick) using a standard hospital glucometer. Exceptions to this need to be approved by the Endocrine team.
2. Remove the sensor and transmitter from the patient before Magnetic Resonance Imaging (MRI), Computed Tomography (CT) scan, or high-frequency electrical heat (diathermy) treatment.
3. Remove the sensor and transmitter from the patient prior to surgery. Medical and nursing staff are required to continue BGL monitoring (by finger-stick) using a standard hospital glucometer during surgery to guide clinical decisions.
4. CGM has not been evaluated or approved in persons on dialysis or in critically ill patients. It is not known how different medical conditions or medications commonly used in the critically ill population may affect performance of CGM. Sensor glucose levels may be inaccurate in critically ill patients. Medications containing paracetamol/acetaminophen can give a false high reading and there are limited data about the effect of other medications on CGM accuracy.
5. In some circumstances, following team discussion and with the approval of the treating endocrinologist, CGM may be used in the hospital setting to provide information in addition to finger stick blood glucose levels. In these situations, the frequency of fingerstick blood glucose monitoring should be stated by the treating endocrinologist and the decision to use CGM should be reviewed at least daily and also at the addition of any new medications or change in clinical situation.

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