



NATIONAL CLINICAL GUIDELINE TITLE:

General Principles in the Management of Children with Diabetes Requiring Surgery

Clinical Design and Innovation
Health Service Executive

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Contents

1.0	Aim of Guideline	3
2.0	Purpose and Scope	3
3.0	Background and Introduction.....	3
4.0	Legislation/other related policies.....	3
5.0	Glossary of terms and definitions.....	3
6.0	Roles and Responsibilities	4
7.0	Clinical Guideline	4
7.1	Overarching Principles	4
7.2	Major surgery	5
7.3	Minor surgery	7
7.4	Emergency Surgery	10
7.5	Type 2 diabetes patients on oral medication alone	10
8.0	Implementation Revision and Audit.....	11
9.0	References	11
10.0	Qualifying Statement	11
11.0	Appendices	12
11.1	Appendix 1.....	12
	ASA Physical Status Classification System	12
11.2	Appendix 2.....	12
	Commonly used Insulin	12
11.3	Appendix 3.....	14
	Acknowledgements.....	14
11.4	Appendix 4.....	14
	Approval Process.....	14
12.0	Guideline Update November 2020	15

1.0 Aim of Guideline

The aim of this guideline is to provide clear and standardised guidelines for all staff caring for paediatric patients with type 1 and 2 diabetes requiring a general anaesthetic or sedation for surgery or another procedure.

2.0 Purpose and Scope

- 2.1 The purpose of this guideline is to improve the management of paediatric patients with diabetes who are required to fast for a procedure or surgery.
- 2.2 This guideline is intended for healthcare professionals, particularly those in training, who are working in HSE-funded paediatric and neonatal services. It is designed to guide clinical judgement but not replace it.
- 2.3 In individual cases a healthcare professional may, after careful consideration, decide not to follow a guideline if it is deemed to be in the best interests of the child

3.0 Background and Introduction

- 3.1 The model of care for Paediatric Anaesthesia (2015) provides a flexible framework for paediatric peri-operative clinical governance enabling different levels of hospitals to be responsive to individual local needs.
- 3.2 Patients with ASA class 3 or greater should be transferred to a specialised children's facility for surgery.
- 3.3 Children with well controlled diabetes are classified as ASA2. Surgery in regional centres on ASA class 2 children with diabetes should only be performed after close liaison between Surgical, Anaesthetic and Paediatric teams.
- 3.4 The Paediatric Anaesthesia model recommends that any child who is anticipated to require PICU care post operatively should be transferred to a tertiary paediatric centre for surgery.
- 3.5 Surgery (minor and major) should be performed when the diabetes is under the best possible control. If glycaemic control is poor, consider admission to hospital prior to surgery for assessment and stabilisation of diabetes.

4.0 Legislation/other related policies

- Model of Care for All Children and Young People with Type 1 Diabetes
- <http://www.hse.ie/eng/about/Who/clinical/natclinprog/paediatricsandneonatology/paedsmoc.pdf>
- Model of Care for Paediatric Anaesthesia

5.0 Glossary of terms and definitions

- 5.1 **Minor surgery** or procedures (endoscopy, adenotonsillectomy, grommet insertion, and dental procedures) are usually of 1 hour or less duration and require a brief GA (or heavy sedation). They should not have a major impact on glycaemic control and patients are usually discharged from hospital on the day of the procedure.

5.2 Major surgery will require a more prolonged GA and is associated with greater risks of metabolic decompensation. The child is unlikely to be discharged from hospital on the day of the procedure

5.3 BG Blood Glucose

Na Sodium

IV Intravenous

6.0 Roles and Responsibilities

6.1 This guideline should be reviewed by each hospital's local paediatric implementation group to appropriately plan implementation. This will ensure that the inpatient care of children/neonates admitted to their facility is optimised irrespective of location.

7.0 Clinical Guideline

INSULIN ADMINISTRATION SAFETY ALERT

INSULIN ERRORS CAN HAVE EXTREMELY SERIOUS CONSEQUENCES-always act on patient/family/HCP concerns re doses and recheck

- Overdoses can cause severe hypoglycaemia, seizures, coma and even death
- Under dosage can result in diabetic ketoacidosis.

Please **INDEPENDENTLY DOUBLE CHECK** doses at each stage-

- When making up an infusion (an insulin syringe graduated in units to measure insulin must be used)
- When infusing via a pump
- When administering via pen (pens and cartridges are SINGLE PATIENT USE ONLY)

ALWAYS CHECK PRESCRIPTION:

- Reconfirm order with the prescriber if unsure/ concerned about the insulin dose
- Avoid abbreviations; insulin should be prescribed in units
- Do not administer an unclear prescription-Prescription **MUST** be rewritten
- Only use an insulin pen or an insulin syringe graduated in units to measure insulin

7.1 Overarching Principles

7.1.1 The Paediatric or Paediatric Endocrinology team should be contacted about any child with Type 1 diabetes undergoing surgery.

7.1.2 Children with Type 1 diabetes need insulin, even if fasting, to avoid ketoacidosis.

7.1.3 Diabetes technology (pumps, continuous glucose monitors (eg dexcom) and free style libre devices) may be affected by x-ray screening and MRIs and may be hazardous with diathermy and where these are required, children with diabetes should be monitored with finger prick BG levels and insulin delivered by SC injection or infusion (see below)

- 7.1.4 Careful blood glucose monitoring is required; hourly checks are recommended in the pre, intra and post-operative periods.
- 7.1.5 Aim to maintain blood glucose in the range of **5-10 mmol/L** during surgical procedures in children.
- 7.1.6 Ideally admit one day prior to elective surgery to ensure adequate control of blood sugars prior to performing procedure. In appropriate circumstances, it may be possible to admit early on the morning of surgery (discuss with paediatric/paediatric diabetes team first).
- 7.1.7 Inform anaesthetic team and theatre staff that child has diabetes and extra monitoring will be necessary during procedure, especially if patient on insulin pump.
- 7.1.8 Ensure patient is **first** on list to avoid prolonged fasting and unstable blood glucose levels.
- 7.1.9 **IV cannula to be inserted on admission and U&E and lab blood glucose to be checked. All results to be reviewed pre-operatively.**
- 7.1.10 All urines to be checked for glucose and ketones.
- 7.1.11 5% w/v glucose/0.9% w/v sodium chloride is usual maintenance intravenous fluid used

7.2 Major surgery

Admit to hospital the afternoon prior to surgery for major operations. Earlier admission is important if glycaemic control is poor. Operations should be scheduled first on list.

7.2.1 Day Before:

- 7.2.1.1 Normal insulin doses and diet.
- 7.2.1.2 Check baseline urea and electrolytes (in particular to ensure normal sodium and potassium levels pre-operatively).
- 7.2.1.3 Monitor capillary blood glucose (BG) before meals and snacks and overnight
- 7.2.1.4 Check for ketones in glucose >14 mmol/L. and report immediately if ketones raised as additional short acting insulin may be required.
- 7.2.1.5 Ketosis or severe hyperglycaemia will necessitate correction and may delay surgery.

7.2.2 Day of Surgery:

- 7.2.2.1 Omit usual morning insulin.
- 7.2.2.2 Start IV maintenance fluids (5% w/v glucose/0.9% w/v sodium chloride) at 7-8 am/2 hours pre-op.
- 7.2.2.3 Start IV insulin (at 7-8am/2 hours pre-op).
- 7.2.2.4 Continuous low dose insulin infusion is the optimal method. A programmable infusion pump, ideally with dose error reduction software (i.e. a 'smart-pump'), should be used.
- 7.2.2.5 Insulin infusions should be prepared in a syringe at a standard concentration as determined by the child's weight. For all children weighing **5kg or more** a 1 unit/1mL solution should be prepared.

Note: For children weighing **less than 5kg** a more dilute concentration of 0.1unit/1mL must be prepared to ensure deliverable volumes and consultation with Paediatric Endocrinology is required at this age

Insulin Infusion - for Children Weighing ≥ 5kg
<ul style="list-style-type: none"> • Dilute 50 units (0.5mL) Actrapid® to a final volume of 50mL with Sodium Chloride 0.9%w/v. [This gives a solution containing 1 unit of insulin /mL] • Connect via a Y connector to the fluids already running.

- Monitor BG levels hourly while on IV insulin infusion
- Insulin infusion should start and be titrated as per Table 2. Suggested Insulin Infusion Rates for Surgical Procedures.

Table 2. Insulin Infusion Titration for Surgical Procedures

	Blood Glucose Level	Insulin Infusion Dose
START DOSE	< 12mmol/l	0.025 units/kg/hr
	> 12mmol/l	0.05 units/kg/hr
BLOOD GLUCOSE LEVELS AT 1 HOUR INTERVALS	< 4 mmol/l	Stop infusion x 15 mins Ensure Dextrose in fluids Recheck BG if > 4mmol/l restart infusion at 0.01 units/kg/hr
	4 - 5.9 mmol/l	↓ 0.01units/kg/hr
	6 - 7.9 mmol/l	Continue 0.025 units/kg/hr
	8 - 11.9 mmol/l	↑ 0.05 units/kg/hr
	12- 14.9 mmol/l	↑ 0.075 units/kg/hr
	>15 mmol/l	↑ 0.1 units/kg/hr Check for Blood Ketones

- 7.2.2.6** Monitor BG at least hourly in theatre and until awake post-operatively for at least 4 hrs. Frequency of monitoring may be reviewed then if stable, awake and back on usual s/c insulin regimen.
- 7.2.2.7** Insulin infusion should not be stopped unless blood glucose is <4 mmol/L as this will cause rebound hyperglycaemia. If blood glucose is < 4mmol/L, discontinue insulin for 15 minutes and then restart at lower rate (eg 0.01units/kg/hr) and monitor BG carefully.
- 7.2.2.8** Add potassium chloride to maintenance fluids if on infusion for > 12 hours and monitor electrolytes
- 7.2.2.9** Continue IV infusion until the child is tolerating oral fluids and snacks.
- 7.2.2.10** There is a risk of hyponatraemia in hospitalized patients. Monitor sodium levels (at least 12 hourly) while on prolonged IV fluids

- 7.2.2.11 Once the child is able to resume oral nutrition, resume the child's usual diabetes regimen.
- 7.2.2.12 Stop IV insulin infusion 30 minutes after subcutaneous insulin recommenced.

7.3 Minor surgery

If the extent of the planned surgery is unclear, it is safer to follow the major surgery guidelines.

7.3.1 Patients treated with twice or three times daily injections (eg Intermediate insulin (Insulatard) with regular insulin (Actrapid) or premixed insulin)

7.3.1.1 Morning surgery

- 7.3.1.1.1 Omit usual morning fast-acting (e.g. Actrapid, Humalog) and give only usual morning intermediate acting insulin (e.g. Insulatard). (If on premixed insulin such as Humilin M3 give only the equivalent dose of the basal component).
- 7.3.1.1.2 Start maintenance IV fluids (5% w/v glucose/0.9% w/v sodium chloride) 1-2 hours pre-operatively or 8am at the latest.
- 7.3.1.1.3 Monitor capillary blood glucose **hourly** (including in theatre).
- 7.3.1.1.4 If blood glucose rises to **>14 mmol/L**, check for ketones and start IV insulin (at 0.05 units/kg/hr) and follow Major Surgery guideline (Section 7.2)
- 7.3.1.1.5 Hourly blood glucose until awake post-operatively for at least 4 hours.
- 7.3.1.1.6 Start oral intake or continue IV fluids depending on child's condition post op. Supplemental rapid acting insulin may be given to treat hyperglycaemia or to cover carbohydrate intake.
- 7.3.1.1.7 Dinner or evening insulin is given as usual and BG monitoring as usual (when stable)
- 7.3.1.2 Afternoon surgery
- 7.3.1.2.1 Give usual dose of morning rapid/fast acting insulin (e.g. Actrapid) and 50% of the usual dose of intermediate-acting insulin (e.g. Insulatard). (If on premixed insulin such as Humilin M3 give only 50% of the equivalent dose of the basal component).
- 7.3.1.2.2 Allow the child to eat a light breakfast.
- 7.3.1.2.3 Start maintenance I.V. fluids (5% w/v glucose/0.9% w/v sodium chloride) 2 hours prior to surgery or no later than midday.
- 7.3.1.2.4 Proceed as for morning operations

7.3.2 Patients treated with multiple daily injections (eg once daily glargine and pre-meal rapid acting insulin)

Doses of long acting insulin should be continued as normal.

7.3.2.2 Morning surgery

7.3.2.2.1 Give regular evening detemir, glargine or degludec (tresiba) the preceding evening. If pre-operative evaluation shows a pattern of low blood glucose values in the morning, consider reducing the dose of long-acting insulin by 20-30%. Note Tresiba has a very long half-life.

7.3.2.2.2 On the morning of the procedure, give the usual dose of long-acting insulin (**Note – ONLY if long acting insulin is usually given at this time daily**).

7.3.2.2.3 Omit the rapid-acting insulin unless a modified dose is needed to correct hyperglycaemia.

7.3.2.2.4 Commence IV fluids (5% w/v glucose/0.9 % w/v sodium chloride) 1-2 hours pre-operatively or no later than 8am. Patients with a normal blood glucose may initially be managed on 0.9 % w/v sodium chloride without additional glucose.

7.3.2.2.5 Monitor BG hourly

7.3.2.2.6 Post-op supplemental mid-morning rapid acting insulin may be given if required.

7.3.2.2.7 When recovered and able to resume normal feeds, afternoon/evening insulin doses should be given as usual and monitor BG as usual.

7.3.2.3 Afternoon surgery

7.3.2.3.1 Give regular evening detemir, glargine or degludec the preceding evening.

7.3.2.3.2 On the morning of the procedure, give the usual dose of long-acting insulin (**Note – ONLY if long acting is usually given at this time daily**).

7.3.2.3.3 Give dose of rapid-acting insulin with breakfast (using usual insulin to carbohydrate dose ratio).

7.3.2.3.4 Commence IV fluids (5% w/v glucose/0.9% w/v sodium chloride) 1-2 hours pre-operatively or no later than midday. Patients with a normal blood glucose may initially be managed on 0.9% w/v sodium chloride without glucose).

7.3.2.3.5 Monitor BG hourly

7.3.3.3.6 Proceed as for morning operations.

7.3.3 *Patients treated with continuous subcutaneous insulin infusion (CSII) / pump therapy*

7.3.3.1 See note 7.1.3 above re specific hazards of technology use with x-ray screening, MRI or diathermy

7.3.3.2 Inform anaesthetic team and theatre staff that child has diabetes and extra monitoring will be necessary during procedure, as patient on insulin pump.

7.3.3.3 Check that subcutaneous infusion site is functioning, secure and visible to prevent dislodgement and interruption of insulin supply before and/or during procedure. The pump site should be changed the day before theatre.

7.3.3.4 **Site to be shown to Consultant Anaesthetist pre-operatively.**

7.3.3.5 Morning surgery

- 7.3.3.5.1** Continue pump at basal rate peri-operatively. *Basal rate can be suspended, if necessary, for no more than 30 minutes to correct any episodes of mild hypoglycaemia (<4mmol/L).*
- 7.3.3.5.2** Do not give morning meal bolus but if necessary can correct hyperglycaemia with correction bolus.
- 7.3.3.5.3** Commence IV maintenance fluids (5% w/v glucose/0.9% w/v sodium chloride) 2 hours pre operatively or 8 am at the latest. Patients with a normal blood glucose may initially be managed on 0.9 % w/v sodium chloride without glucose.
- 7.3.3.5.4** Monitor BG levels hourly pre, intra and post-operatively aiming to keep between 5-10 mmol/L; temporary basal rates may be used to achieve this target (under supervision of paediatric/paediatric endocrinology team).
- 7.3.3.5.5** When necessary correction doses can be given with pump pre and post operatively.
- 7.3.3.5.6** A meal bolus is given when patient is ready to eat carbohydrate.

7.3.3.6 Afternoon surgery

- 7.3.3.6.1** Light breakfast with appropriate meal bolus and continue basal rate.
- 7.3.3.6.2** Fast as per anaesthetic guidelines.
- 7.3.3.6.3** Commence IV maintenance fluids (5% w/v glucose/0.9% w/v sodium chloride) 2 hrs. pre-op or midday at the latest. Patients with normal blood glucose may initially be managed on 0.9% w/v sodium chloride without glucose.
- 7.3.3.6.4** Monitor BG hourly
- 7.3.3.6.5** Proceed as for morning operations.

7.4 Emergency Surgery

DKA can present as an “acute abdomen” in new presentation of diabetes and in known patients with diabetes. Acute illness may precipitate DKA.

7.4.1 Pre-operative care

- 7.4.4.1 Check blood glucose, venous gas, blood / urine ketones and urea and electrolytes
- 7.4.4.2 Check weight if possible.
- 7.4.4.3 **If ketoacidotic (pH < 7.3 and bicarb < 18 mmol/L),** manage as per DKA guidelines and inform Anaesthetist and Paediatric/Paediatric Endocrinology Team.
- 7.4.4.4 Surgery will need to be deferred until circulating volume and electrolyte deficits have been corrected.
- 7.4.4.5 If not in DKA/ ketoacidotic (normal pH (> 7.3), normal bicarb (>18mmol/L)), start IV fluids and insulin management as for elective surgery.
- 7.4.4.6 Inform the Paediatric/ Paediatric Endocrinology team.

7.4.2 Post-operative care

- 7.4.2.1 After surgery, start oral intake or continue IV fluids depending on the child’s condition. Continue IV insulin infusion/additional short- or rapid-acting insulin until oral intake resumed and tolerated.
- 7.4.2.2 Hourly blood sugars should continue until oral intake re-established.
- 7.4.2.3 Once the child is able to eat, resume the usual diabetes regimen.
- 7.4.2.4 If the BG rises or the patient starts vomiting, the clinical situation needs to be reviewed (and may require blood samples for electrolytes and gases (to exclude DKA)).

7.5 Type 2 diabetes patients on oral medication alone

- 7.5.1 Metformin use has been associated with lactic acidosis, especially in cases of renal insufficiency and vomiting illness
- 7.5.2 For paediatric patients with type 2 diabetes, metformin should be discontinued in the peri-operative period.

7.5.3 Major surgery (>2 hours duration)

- 7.5.3.1 Metformin should be discontinued 24 hours before the procedures.
- 7.5.3.2 In the case of emergency surgery (where patient has had last metformin dose <24 hours), it is important to maintain hydration with IV fluids before, during, and after surgery.

7.5.4 Minor surgery (<2 hours duration)

- 7.5.4.1 Metformin may be discontinued on the day of surgery
- 7.5.4.2 In all cases metformin should be withheld for 48 hours after surgery and until normal renal function has been confirmed. Additional blood glucose monitoring is required.

8.0 Implementation Revision and Audit

- 8.1 Distribution to the CEO of each Hospital Group for dissemination through line management in all acute hospitals within their group.
- 8.2 Implementation through Senior Management Teams of each acute hospital.
- 8.3 Distribution to other interested parties and professional bodies
- 8.4 The NCPPN Diabetes Working group has agreed that this guideline will be reviewed on a 3 yearly basis.
- 8.5 Regular audit of implementation and impact of this guideline through outcome and process measures is recommended to support continuous quality improvement. It is the responsibility of each unit providing care for children with diabetes and intercurrent illness to audit the unit practice regularly in order to ensure that care in being provided in line with guidelines and that any deviations are clinically justified. The audit process should be coordinated in each paediatric unit under local paediatric clinical governance and should be taken from a multidisciplinary perspective where appropriate. Where the audit identifies areas for practice improvement, it is the responsibility of each individual unit to implement changes and re-audit to support continuous quality improvement.

9.0 References

- Betts P, Brink S et al. (2009) *International Society for Paediatric and Adolescent Diabetes: ISPAD Clinical Practice Consensus Guidelines*, Paediatric Diabetes; 10 (Supp 12):169-174
- Rhodes ET, Gong C et al. (2014) *International Society for Paediatric and Adolescent Diabetes ISPAD Clinical Practice Consensus Guidelines*, Paediatric Diabetes; 15 (Supp 20):224-231.
- Previous Children's University Hospital: Temple Street Surgical guidelines for children with Type 1 diabetes.
- Irish Medication Safety Network (2020) Best Practice Guidelines for the Safe Use of Insulin in Irish Hospitals <https://imsn.ie/wp-content/uploads/2020/07/insulin-best-practice-March-2020-with-appendices.pdf>

10.0 Qualifying Statement

- 10.1 These guidelines have been prepared to promote and facilitate standardisation and consistency of practice.
- 10.2 Clinical material offered in this guideline does not replace or remove clinical judgement or the professional care and duty necessary for each child.
- 10.3 Clinical care carried out in accordance with this guideline should be provided within the context of locally available resources and expertise.
- 10.4 This Guideline does not address all elements of standard practice and assumes that individual clinicians are responsible for:
 - Discussing care with the child, parents/guardians and in an environment that is appropriate and which enables respectful confidential discussion.

- Advising children, parents/guardians of their choices and ensure informed consent is obtained.
- Meeting all legislative requirements and maintaining standards of professional conduct.
- Applying standard precautions and additional precautions, as necessary, when delivering care.
- Documenting all care in accordance with local and mandatory requirements.

11.0 Appendices

11.1 Appendix 1

ASA Physical Status Classification System

ASA Physical Status 1 – A normal healthy patient

ASA Physical Status 2 – A patient with mild systemic disease

ASA Physical Status 3 – A patient with severe systemic disease

ASA Physical Status 4 – A patient with severe systemic disease that is a constant threat to life

ASA Physical Status 5 – A moribund patient who is not expected to survive without the operation

ASA Physical Status 6 – A declared brain-dead patient whose organs are being removed for donor purposes

11.2 Appendix 2

Commonly used Insulin

- **Rapid acting**

Rapid acting insulin analogues eg Novorapid (aspart) /Apidra (glulisine)/Humalog (lispro)/FIASP (fast acting aspart)

- **Fast acting**

Regular human insulin e.g

Actrapid (regular insulin),

Humulin S (regular insulin)

Insuman Rapid (regular insulin)

- **Intermediate**

Insulatard (NPH -Neutral Protamine Hagedorn)

Humulin I (NPH -Neutral Protamine Hagedorn)

- **Long acting**

Levemir Insulin (detemir)

Lantus (glargine)

Toujeo (longer acting lantus)

Tresiba (degludec)

Abasagar

- **Premixed insulin**

Humulin M3 (30% regular (fast) and 70% intermediate)

Humalog Mix 25 (25% rapid / 75% intermediate)

Humalog Mix 50 (50% rapid / 50% intermediate)

Novomix 30 (30% rapid and 70% intermediate)

11.3 Appendix 3

Acknowledgements

This guideline has been developed by the National Clinical Programme for Paediatrics and Neonatology Diabetes Working Group. The members of this group include medical, nursing and dietetic representatives from paediatric diabetes services. The Diabetes Working Group also wish to thank those who provided input and feedback on draft versions of this guideline throughout development, and those who provided valuable input during the consultation process and revision of the guideline including Ms. Ciara Kirke, Clinical Lead, National Medication Safety Programme, HSE and Mr. Donal Burke, Clinical Pharmacist, CHI, Crumlin

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11.4 Appendix 4

Approval Process

Sign off by Paediatric Diabetes Working Group	December 2018
Sign off by Paediatric Clinical Advisory Group	December 2018
Sign off by HSE CSPD Senior Management Team	January 2019
Guideline update approved by Paediatric Working Group	November 2020
Guideline update approved by Paediatric Clinical Advisory Group	March 2021
Guideline update approved by National Clinical Advisory Group Lead	April 2021

12.0 Guideline Update November 2020

1. Addition of insulin safety alert
2. Change of wording to units rather than iu for insulin
3. Normal saline changed to 0.9% w/v sodium chloride
4. Dextrose changed to glucose