Management of Diabetes During Surgery

Purpose

The purpose of this guideline is to advise medical and surgical teams on the diabetic management of children and young people with type 1 diabetes who are having surgery at Sheffield Children’s Hospital.

Intended Audience

This guideline applies to all registered nursing staff and clinicians working within Sheffield Children's Hospital involved in caring for children with Type 1 diabetes.
1. Introduction

Children with diabetes mellitus are at risk of blood glucose (BG) disturbance when undergoing surgery. This risk results from a change in routine, change 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 to keep good 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. Intended Audience

This guideline is intended to be used for managing all children and young people up to the age of 18 years with diabetes mellitus type 1 who are having surgery in Sheffield Children’s Hospital.

3. Guideline Content

3a. 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 60 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 upper GI endoscopy, myringotomy, incision and drainage.

N.B. Lower GI endoscopies are minor procedures but need prolonged fasting for solids pre-operatively. This means that patients are at risk of hypoglycaemia while fasting and most likely will need overnight admission. The operating team should liaise with the diabetes team well in advance to agree on a diabetes management plan on an individual case basis.

Major surgery: Includes all surgery requiring more prolonged general anaesthesia lasting >60 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

3b. Pre-operative Fasting Guidelines
- No solid food should be consumed for 6 hours before elective surgery in children.
- In infants aged up to 12 months, breast milk is safe up to 3 hours and formula milks up to 4 hours. All children should be encouraged to drink clear fluids freely (including water, low-sugar squash) up to 2 hours before elective surgery. Current fasting guidelines allow children to continue to sip clear fluids until called to theatre. Where this is not possible, intravenous (IV) fluids should be started.

3c. Peri-operative Blood Glucose Targets
- BG should be kept between 5-11.1 mmol/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.

3d. Emergency Surgery

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<thead>
<tr>
<th>Before surgery</th>
<th>On arrival, weigh patient, measure capillary and plasma BG, venous blood gases, blood ketones, electrolytes, urea and creatinine.</th>
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<td></td>
<td>o Inform diabetes Team on admission. (switchboard will know who is on-call): a senior member will discuss management with Anaesthetists and Surgeons</td>
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Author: Astha Soni
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### Management of Diabetes During Surgery

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<th>If ketoacidotic</th>
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<tr>
<td>Follow Trust guidelines on Diabetic Ketoacidosis (DKA)</td>
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<tr>
<td>Operate when rehydrated, blood pressure is stable, blood gas is normal, sodium and potassium in normal range.</td>
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<tr>
<td>Blood glucose levels should also be stable ideally between 5 and 11.1 mmol/l</td>
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<td>This may not be possible for some life-saving operations.</td>
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<table>
<thead>
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<th>If not ketoacidotic</th>
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<td>Follow guideline on major elective surgery and start fluid maintenance and intravenous insulin (sections 3e and 3f)</td>
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<td>For those on insulin pumps, the pump should be stopped once the IV infusion is started.</td>
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<tr>
<th>If on a Multiple Daily Injection (MDI) regimen:</th>
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<tbody>
<tr>
<td>Always give basal insulin analogue (subcutaneous insulin Glargine or Levemir) at usual time even if still on IV fluids and sliding scale of insulin</td>
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### After surgery
- 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 4c for guide on how to change back to subcutaneous insulin

### 3e. Major Elective Morning Surgery

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<th>Day Before surgery</th>
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<td>Admit day before surgery</td>
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<td>Weight, U&amp;E, FBC, true BG, urine or blood for ketones</td>
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<tr>
<td>Pre-meal and pre-bedtime capillary BG on the ward</td>
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<tr>
<td>Usual insulin the evening and night before surgery</td>
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<tr>
<td>For those on insulin pumps continue pump as usual with parental management until the time of surgery</td>
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<table>
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<tr>
<th>Morning of surgery</th>
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<tr>
<td>Nothing to eat 6 hours before operation. For morning lists patients should be starved from 02:30 but can freely drink clear fluids until 2 hours before surgery and take sips of fluid thereafter.</td>
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<tr>
<td>Omit rapid-acting insulin in the morning</td>
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<tr>
<td>Glargine (Lantus) or Detemir (Levemir) if given in the morning, should be given in FULL.</td>
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<tr>
<td>Start IV maintenance fluids at maintenance rate and IV insulin according to sliding scale at 06.30, to maintain BG level between 5 and 11.1mmol/l. (see sections 4a &amp;4b)</td>
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</table>

For those on insulin pumps:
- Continue pump as usual with parental management until the time of surgery.
- Start pre-prepared glucose / insulin infusions at anaesthetic induction.
### For all patients
- Measure capillary BG pre-theatre and half-hourly during surgery

### After surgery:
- Measure BG half-hourly for the first two hours, hourly for four hours and then two-hourly until next morning. Continue IV fluids and IV insulin infusion until ready to start eating.
- Go to section 4c for guide on how to change back to subcutaneous insulin.
- Always give basal insulin analogue (subcutaneous insulin Glargine or Levemir) at usual time even if still on IV fluids and sliding scale of insulin.

#### 3f. Major Elective Afternoon Surgery

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<tr>
<th>Day before surgery</th>
<th>Morning of surgery <strong>First on afternoon list</strong></th>
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<tr>
<td>o Admit</td>
<td>o Light breakfast at 0700 on the morning of procedure, and then starve, but check with anaesthetists for exact timing. Sip clear fluids until theatre.</td>
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</tbody>
</table>
| o Weight, U&E, FBC, true BG, urine or blood for ketones | If on a Multiple Daily Injection (MDI) regimen:  
  o Rapid-acting insulin should be taken at the FULL usual dose according to carbohydrate content of breakfast, as well as usual correction dose depending on pre-meal BG level (BGL).  
  o Basal insulin analogue (e.g. Glargine or levemir) if given in the morning, should also be given in FULL  
  o IV fluid infusion from 12 noon and IV insulin infusion (see sections 4a & 4b). |
| o Pre-meal and pre-bedtime capillary BG on the ward | If on a twice or three times daily insulin regimen:  
  o Give HALF the morning insulin dose  
  o IV fluid infusion from 12 noon and IV insulin infusion (see sections 4a & 4b). |
| o Usual insulin the evening and night before surgery | For those on insulin pumps:  
  o Continue pump as usual with parental management until the time of surgery.  
  o Start pre-prepared glucose / insulin infusions at anaesthetic induction. |
| o For those on insulin pumps continue pump as usual with parental management until the time of surgery | For all patients  
  o Measure capillary BG pre-theatre and half-hourly during surgery |
| After surgery      |                                               |
| o Measure BG half-hourly for the first two hours, hourly for four hours and then two-hourly until next morning. Continue IV fluids and IV insulin infusion until ready to start eating  
  o Go to section 4c for guide on how to change back to subcutaneous insulin.  
  o Always give basal insulin analogue (subcutaneous insulin Glargine or Levemir) at usual time even if still on IV fluids and sliding scale of insulin |
3g. Minor Elective Morning Surgery

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<th>Day before surgery</th>
<th>Advised normal insulin and diet</th>
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<td>Morning of procedure</td>
<td>o Child can be admitted on the morning of the surgery</td>
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<td></td>
<td>o Child should be first on the list ideally</td>
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<td>o IV Cannula to be placed by the anesthetist at induction.</td>
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<td>o No IV fluids or insulin infusion needed</td>
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<td></td>
<td>o Measure and record the capillary BG hourly preoperatively and half-hourly during the operation</td>
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If on a **Multiple Daily Injection (MDI) regimen:**
- If BG is 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 procedure when they can have it with the late breakfast.
- If basal insulin analogue (glargine or levemir) is usually given in the morning continue to give it as usual.

If on a **Twice daily or three times daily regimen:**
- delay the morning dose till after procedure when they can have it with a late breakfast

For those patients on **insulin pumps:**

**Prior to surgery:**
- Run the pump at the usual basal rate
- Check BG hourly and ask parents to adjust basal rates to maintain BG between 5-11.1 mmol/l
- Anaesthetist must become familiar with the basic functions of the patient’s pump, particularly how to temporarily suspend the basal infusion (see Trust guideline on insulin pumps).

**During surgery:**
- 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 more than an hour (in case BG is still low after 30 minutes), the child must be started on IV insulin and intravenous fluid (as per section 4a and 4b) as they have NO basal insulin in their body.

**However, FOR ALL INSULIN REGIMENS:**
- BG should be checked hourly once nil by mouth and half-hourly during the operation.

**IF:**
- BG <5 mmol/l – give bolus of IV 10% Glucose 2ml/kg; recheck BG 15 minutes later
- BG >12 mmol/l – start IV insulin infusion and IV fluids as per sliding scale in sections 4a and 4b.
- If for some reason procedure is delayed for a further 2 hours or
### After procedure

- Once eating, give usual dose rapid acting insulin generally taken with that meal.
- If needing IV fluids & insulin infusion Go to section 4c for guide on how to change back to subcutaneous insulin.

#### Insulin pump regimen
- Allow parents to re-start / continue the pump at the usual basal rate once the child has recovered.
- Home when eating and drinking, regardless of BG level if parents are happy; parent will control better at home. If in doubt, discuss with diabetes team.

### 3h. Minor Elective Afternoon Surgery

#### Day before procedure
- Advise usual doses of insulin night before procedure.

#### Morning of 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:
  
  **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) if given in the morning, should also be given in FULL.

  **twice or three times daily insulin regimen:**
  - Give HALF of rapid-acting component of morning dose as rapid-acting insulin. Example: if usual morning dose is 10 units of Novomix 30 or Humulin M3, then the usual fast acting component is 3/10 x10=3 units of rapid acting insulin (e.g insulin aspart (NovoRapid), Humalog lispro (Humalog), glulisine (Apidra)).

**For those patients on insulin pumps:**

**Prior to surgery:**
- Run the pump at the usual basal rate.
- Usual bolus with breakfast.
- Check BG hourly and ask parents to adjust basal rates to maintain BG between 5-11.1 mmol/l.
- Anaesthetist must become familiar with the basic functions of the patient’s pump, particularly how to temporarily suspend the basal infusion (see Trust guideline on sc insulin pumps).

**However, FOR ALL INSULIN REGIMENS:**
- BG should be checked hourly once nil by mouth and half-hourly during the operation.

**IF:**
- BG <5 mmol/l – give bolus of IV 10% Glucose 2ml/kg; recheck BG 15 minutes later.
- BG >12 mmol/l – start IV insulin infusion and IV fluids as per sliding scale in sections 4a and 4b.
- If for some reason procedure is delayed for a further 2 hours or child has had repeated low BGs, start on maintenance IV fluids (section 4a)

### Peri-operatively
- Measure and record capillary BG on arrival
- IV cannula to be inserted by the anesthetists at induction
- 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

### For those patients on insulin pumps
- Run the pump on the normal basal setting for the duration of the procedure.
- 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 more than an hour (in case BG is still low after 30 minutes), the child must be started on IV insulin and intravenous fluid as per section 4a & 4b as they have NO basal insulin in their body.

### After procedure
- Once eating, give usual dose rapid acting insulin generally taken with that meal
- If needing IV fluids & insulin infusion Go to section 4c for guide on how to change back to subcutaneous insulin

### Insulin pump regimen
- Allow parents to re-start / continue the pump at the usual basal rate once the child has recovered.
- Home when eating and drinking, regardless of BG level; parent will control better at home

Detailed information about the commonly used SC insulin pumps is provided in the Medical Handbook Guideline 288: General management of diabetic patients and a brief guide to insulin pumps.

**If in doubt give IV insulin in conventional manner!!**
4. Practical Guides

4a. Maintenance IV Fluid Infusion Guide

0.45% Sodium chloride and 5% glucose plus Potassium 10mmol/500ml.

<table>
<thead>
<tr>
<th>IV Fluid Infusion Guide (as per SC[NHS]T Fluid Policy):</th>
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<tr>
<td>1st 10 kg</td>
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<tr>
<td>Next 10 – 20 kg</td>
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<td>Further &gt;20 kgs</td>
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Example

| Example | | A 23 kg child would require: |
|-------------------|------------------|
| 1st 10 kg | 10 x 100 = 1,000 ml |
| 10 – 20 kg | 10 x 50 = 500 ml |
| 3 kg | 3 x 20 = 60 ml |
| 23 kgs | = 1,560ml over 24 hours |

Please use 0.9% Sodium chloride in addition to maintenance fluids for replacing ongoing significant losses (NG aspirates, stoma losses, etc)

4b. Insulin Infusion Guide

50 units soluble insulin (0.5ml) in 49.5 ml Sodium chloride 0.9% (to make a final volume of 50ml) – pharmacy have prefilled premixed syringes available (1ml solution = 1 unit soluble insulin). Pre-filled insulin syringes are stocked on Ward 1, Ward 3 and PICU.

- Start infusion at
  - 0.02 ml/kg/h (i.e., 0.02 Unit/kg/hour) if BG is between 5–7.9 mmol/l,
  - 0.05 ml/kg/h if BG 8–11.9 mmol/l,
  - 0.07 ml/kg/h for BG 12–14.9 mmol/l
  - 0.1 ml/kg/h for BG 15-19.9 mmol/l.
  - If blood glucose above 20 mmol/l contact diabetes team.

**NB:** If BG is <5mmol/l, give 2ml/kg 10% glucose and continue maintenance fluid. Do not start insulin infusion until rechecked and BG >7mmol/l.

- Monitor BG hourly before surgery and every 30minutes 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.
- See appendix for ‘Drug administration card for intravenous fluids and insulin for children undergoing general surgery’.
4c. How to change back to subcutaneous insulin

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

- **For those patients on twice or three times a day injection regimen NOT using long acting basal insulin e.g. Glargine,** allow to eat but continue IV insulin sliding scale until evening meal then give usual dose of insulin with evening meal.

- **For those patients on insulin regimens using long acting basal insulin e.g. Glargine/ Levemir,** give rapid acting insulin with lunch. Check that Long-acting insulin has been carried on throughout stay. Give rapid acting insulin with evening meal and long-acting insulin analogue at usual time. 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** – 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 twice or three times a day injection regimen NOT using long acting basal insulin analogue e.g. Glargine,** give usual dose of insulin with evening meal.

- **For those patients on multiple injection regimen with long acting basal insulin analogue e.g. Glargine,** give rapid acting insulin with evening meal and long-acting insulin analogue at usual time.

- Always give dose of long acting basal insulin analogue e.g. Glargine at usual time even if still on intravenous fluids and intravenous insulin overnight to prevent rebound hyperglycaemia:

  - Stop IV insulin 60 minutes after subcutaneous insulin has started if the child is first given a pre mixed insulin or long acting basal insulin analogue dose.

  - Stop IV insulin 10 minutes after sc insulin has started if the child is given a rapid acting insulin dose

- **For those patients on insulin pump** – 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. Parents should be allowed to manage according to their usual practice
5. References

1. Care of children under 18 years with Diabetes Mellitus undergoing surgery-ACDC guidelines
6. Appendix

Drug prescription and administration card for intravenous fluids and insulin for children undergoing general anaesthesia

**INTRAVENOUS INSULIN INFUSION FOR CHILDREN**

<table>
<thead>
<tr>
<th>Date</th>
<th>Drug/Fluid</th>
<th>Time</th>
<th>Volume infused</th>
<th>Cumulative volume infused</th>
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<th>Date infusion</th>
<th>Date infusion</th>
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<tr>
<td></td>
<td>0.45% Sodium Chloride &amp; 5% Glucose &amp; 10mmol L in 500ml potassium</td>
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**Monitor for signs of hypoglycaemia. See NICE guidelines.**

**Sheffield Children’s NHS Foundation Trust**

**Author:** Astha Soni

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Review date: December 2021
## Management of Diabetes During Surgery

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Astha Soni

### Review date:
December 2021

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### INTRAVENOUS FLUIDS

**General Guidelines**

- Pre-anaesthetic care:
  - Blood glucose levels should be monitored.
  - Adjust insulin doses accordingly.

- During the surgery:
  - Blood glucose levels should be maintained between 5 - 10 mmol/L.

### Pre-operative Care

1. **Pre-op Glucose Check:**
   - Blood glucose levels should be checked before surgery.

2. **Insulin Adjustment:**
   - Adjust insulin doses based on blood glucose levels.

### Intra-operative Care

- **Blood Glucose Monitoring:**
  - Blood glucose levels should be monitored every hour.

### Post-operative Care

1. **Post-op Glucose Check:**
   - Blood glucose levels should be checked post-operatively.

2. **Insulin Adjustment:**
   - Adjust insulin doses based on blood glucose levels.

### Example

**Pre-op Glucose Check:**

- Blood glucose level: 5.5 mmol/L
- Insulin dose: 0.5 units

**Intra-operative Glucose Check:**

- Blood glucose level: 8.2 mmol/L
- Insulin dose: 1 unit

**Post-op Glucose Check:**

- Blood glucose level: 6.8 mmol/L
- Insulin dose: 0.5 units

### Instructions for Patients

- **Pre-op Instructions:**
  - Monitor blood glucose levels daily.

- **Intra-op Instructions:**
  - Follow the surgeon's instructions.

- **Post-op Instructions:**
  - Follow the surgeon's instructions.

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**Drug Allergies or Adverse Drug Reactions:**

Yes, see main drug card.

**NHS Foundation Trust:**

Sheffield Children's (NHS) Foundation Trust

**Management of Diabetes During Surgery**

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**Date:**

**Weight:**

**Date:**

**Prescriber:**

**Date & Time:**

**Signed by:**

**Time:**

**Prescriber:**

**Time:**

**Signed by:**

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**Full Name:**

**Address:**

**Date of Birth:**

**Hospital Number:**

**NHS Number:**

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**Full Name:**

**Address:**

**Date of Birth:**

**Hospital Number:**

**NHS Number:**

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**Full Name:**

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**Hospital Number:**

**NHS Number:**