

Table 1. Perioperative / Periprocedure Management of Hyperglycemia and Hypoglycemia

BG* Levels	Initial BG Check	Ongoing Management																				
BG < 45 mg/dl	<ul style="list-style-type: none"> Confirm most recent diabetes medication / insulin dose and time taken. Insert IV of 0.9% normal saline. Give 50 ml (1 amp) D50. Notify Anesthesia. 	<ul style="list-style-type: none"> Re-check every 15 min and treat accordingly until BG is \geq 80 mg/dl. Once BG > 80 mg/dl, re-check in 30 min and resume hourly glucose monitoring and management according to glucose values on this table. 																				
BG 45-59 mg/dl	<ul style="list-style-type: none"> Confirm most recent diabetes medication / insulin dose and time taken. Insert IV of 0.9% normal saline. Give 25 ml (½ amp) D50 (12.5 g). Notify Anesthesia. 	<ul style="list-style-type: none"> Re-check every 15 min and treat accordingly until BG is \geq 80 mg/dl. Once BG > 80 mg/dl, re-check in 30 min and resume hourly glucose monitoring and management according to glucose values on this table. 																				
BG 60-79 mg/dl	<ul style="list-style-type: none"> Confirm most recent diabetes medication / insulin dose and time taken. Insert IV of 0.9% normal saline. Give 15 ml D50 (7.5 g). Notify Anesthesia. 	<ul style="list-style-type: none"> Re-check every 15 min and treat accordingly until BG is \geq 80 mg/dl. Once BG > 80 mg/dl, re-check in 30 min and resume hourly glucose monitoring and management according to glucose values on this table. 																				
BG 80-139 mg/dl	<ul style="list-style-type: none"> Confirm most recent diabetes medication / insulin dose and time taken. Monitor. 	<ul style="list-style-type: none"> Re-check in 1 hour. 																				
BG 140-180 mg/dl GOAL	<ul style="list-style-type: none"> Confirm most recent diabetes medication / insulin dose and time taken. Monitor. 	<ul style="list-style-type: none"> Re-check in 1 hour. 																				
BG > 180 mg/dl	<ul style="list-style-type: none"> If anticipated procedure time > 3 hrs., consider insulin drip**. If anticipated procedure time < 3 hrs., confirm most recent diabetes medication / insulin dose and time taken. If diabetes medication / insulin dose taken within last 2 hrs., monitor patient, re-check BG in 1 hr. If no diabetes medication / insulin dose given for > 2 hrs., order and give lispro or aspart SQ based on the chart below. <table border="1" data-bbox="321 1516 1026 1843"> <thead> <tr> <th rowspan="2">Blood Glucose</th> <th colspan="2">Dose of Lispro Insulin</th> </tr> <tr> <th>Type 1 DM or Insulin-Naïve Patients</th> <th>Type 2 DM Patients</th> </tr> </thead> <tbody> <tr> <td>180-200</td> <td>1 unit</td> <td>2 units</td> </tr> <tr> <td>201-250</td> <td>2 units</td> <td>4 units</td> </tr> <tr> <td>251-300</td> <td>3 units</td> <td>6 units</td> </tr> <tr> <td>301-349</td> <td>4 units</td> <td>8 units</td> </tr> <tr> <td>> 350</td> <td colspan="2">If BG >350 mg/dl, notify Anesthesia and surgeon. Consider delaying case. Start IV insulin drip**</td> </tr> </tbody> </table>	Blood Glucose	Dose of Lispro Insulin		Type 1 DM or Insulin-Naïve Patients	Type 2 DM Patients	180-200	1 unit	2 units	201-250	2 units	4 units	251-300	3 units	6 units	301-349	4 units	8 units	> 350	If BG >350 mg/dl, notify Anesthesia and surgeon. Consider delaying case. Start IV insulin drip**		<ul style="list-style-type: none"> Re-check BG in 1 hr. If 2 doses given in previous 5 hrs. and BG > 200 mg/dl, start IV insulin drip. DO NOT re-dose supplemental insulin more frequently than Q2H.
Blood Glucose	Dose of Lispro Insulin																					
	Type 1 DM or Insulin-Naïve Patients	Type 2 DM Patients																				
180-200	1 unit	2 units																				
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* BG = blood glucose

**Start insulin drip according to hospital guidelines. See OSUWMC [Continuous Subcutaneous Insulin Infusion \(CSII\) Pumps and Continuous Glucose Monitors \(CGM\) guideline](#).

Preoperative/Preprocedure Phase

General Considerations

- **Prior to Scheduling Procedure / Surgery**
 - Morning procedures are preferred.
 - Check HbA1C (i.e., for intermediate / high-risk surgery) if patient is known or suspected to have diabetes, and if not available within the last 30 days.
 - If poor glycemic control (HbA1C > 9%):
 - Patient to contact referring physician for medication adjustment.
 - Consider postponing non-emergent surgery/procedure until medication adjustments are made.
- **Hypoglycemia Assessment**
 - Frequency, severity, hypoglycemia unawareness, or fasting hypoglycemia.
 - History of renal or liver disease.

Preoperative/Preprocedure Diabetes Medication Adjustment

- **Note:** This guideline is intended for use in patients whose glucose is well controlled.
- Adjust medications based on:
 - Diabetes type
 - Glycemic control
 - Duration of procedure
 - Time of day
- When appropriate, provide patient with [medication management handout](#).

Oral Medications

- **Metformin:** Instruct patients to hold all metformin-containing products the day of surgery.
- Hold all other oral or non-insulin injectable diabetes medications the morning of the procedure.

Insulin

- **Rapidly Acting Insulin** (*lispro, aspart, glulisine*)
 - Hold the morning of procedure unless patient uses correction dosing in the fasting state.
- **Short-Acting Insulin** (*Regular*)
 - Hold the morning of procedure unless patient uses correction dosing in the fasting state.
- **Basal Insulin** (NPH, glargine, detemir)
 - Patients with type 1 and type 2 diabetes may require dose reduction prior to surgery.
 - The dose reduction depends upon glucose control prior to surgery and the total daily insulin dose (basal + prandial) before surgery (approximately 50% or less of the total daily dose is truly basal insulin).
 - **Do not withhold basal insulin in patients with type 1 diabetes.**

- **Regular Insulin (U500)**
 - Instructions per the patient's endocrinologist.
 - See [Regular Insulin U-500 Policy](#) by OSUWMC Pharmacy.

NPH and Lente

- For a.m. procedure, reduce evening dose by 20% and morning-of dose by 50%.
- For p.m. procedure, reduce morning-of dose by 50%.

Glargine (U100, U300), Detemir, Degludec (U100, U200)

- For once-a-day basal insulin, reduce the morning-of or the evening-before dose by 20-50%.
- Patients with type 2 diabetes will need larger dose reductions (50%), particularly if basal insulin accounts for more than 50% of the total daily insulin dose.
- Patients with type 1 diabetes typically only need to reduce the dose by ≤ 20%.

Split-Mixed Insulin (70/30, 75/25, 50/50)

- Reduce evening dose prior to procedure by 20%, and reduce morning-of dose by 50%.

Pump Basal Insulin

- Consider 20% reduction to basal rates to begin at midnight prior to procedure.

Table 2. Preparation and Pharmacokinetics of Insulin

Preparation	Action Onset	Peak	Action Duration
Bolus Insulin			
Regular q.a.c.	30 min.	2-4 hr.	6-10 hr.
Aspart q.a.c.	5-15 min.	1-2 hr.	4-6 hr.
Glulisine q.a.c.	5-15 min.	1-2 hr.	4-6 hr.
Lispro q.a.c.	5-15 min.	1-2 hr.	4-6 hr.
Basal Insulin			
NPH daily or bid	1-2 hr.	4-8 hr.	10-20 hr.
Detemir daily or bid	3-4 hr.	Nearly flat	Approx. 24 hr.
Glargine daily	3-4 hr.	Nearly flat	Approx. 24 hr.
Glargine U300	6 hr.	Nearly flat	24-30 hr.
Degludec U100/U200	1 hr.	Nearly flat	24-30 hr.
Other			
70/30, 75/25, 50/50 bid	5-15 min.	1-2 hr.	10-20 hr.

Intraoperative/Intraprocedure Phase

Glucose Target

- Intraoperative / intraprocedure target:
 - 140-180 mg/dl.
- Refer to **Table 1**.

Glucose Monitoring

- **Patients with diabetes:**
 - Check blood glucose upon arrival to the ASU/Preoperative/Preprocedure holding area.
 - Blood glucose checks should be performed hourly while in ASU/Preoperative/ Preprocedure area, and intraoperatively.
 - For patients undergoing monitored anesthesia care, frequency of monitoring will be determined by the attending anesthesiologist. However, if preoperative BG <70, glucose should be monitored hourly.
 - If blood glucose is out of acceptable range, follow **Table 1** regarding hypoglycemic/hyperglycemic management.
- **Patients without known diabetes:**
 - Consider checking if:
 - Body mass index ≥ 27 kg/m².
 - First-degree relative with diabetes.
 - High-risk ethnic population (African American, Hispanic, Native American, Asian).
 - Delivered a baby weighing > 9 lb or gestational diabetes.
 - Hypertension.
 - HDL cholesterol ≤ 35 mg/dl and/or triglycerides ≥ 250 mg/dl.
 - If blood glucose is >180 mg/dl, follow the recommendations for monitoring in patients with diabetes.

Continuous Subcutaneous Insulin Pump (CSII)

- CSII may be continued for procedures lasting < 3 hours, at discretion of person performing procedure.
- Reduce basal rates by 20%, starting at midnight.
 - Basal adjustments should be discussed with pump prescriber prior to procedure.
- If CSII discontinued for more than 1 hour, coverage with supplemental insulin **MUST** be provided.
- If CSII will be discontinued for > 3 hours, start IV insulin infusion per [Continuous Subcutaneous Insulin Infusion \(CSII\) Pumps and Continuous Glucose Monitors \(CGM\) Policy](#).
- The catheter should be in a site that will not interfere with the surgical field.

IV Insulin Infusion– Indications

- Procedures > 3 hours.
- Poor glycemic control:
 - HbA1C > 9%.
 - BG > 300 mg/dl.
 - BG > 200 mg/dl refractory to supplemental insulin.

Postoperative/Postprocedure Phase

- Check blood glucose immediately upon arrival to PACU/Postprocedure holding area and hourly thereafter while blood glucose within the acceptable range.
- If blood glucose is not within the acceptable range, follow **Table 1** on page 1 for blood glucose correction.
- If patient is to be discharged to home, check blood glucose readings prior to leaving the hospital.
- If patient arrives to the PACU on insulin drip and will be admitted to the floor service, continue the insulin drip when discharged to the floor (following guidelines for insulin infusion):
 - [Type 1 DM and DKA.](#)
 - [Type 2 DM.](#)
 - [DM in Pregnancy.](#)
 - [DM in Non-Pregnant Adults.](#)

Outpatient Procedures

Oral Medication

- Diabetes medications may be resumed once the patient is eating.
- **Metformin:** If there are no contraindications and renal function is normal, resume medications containing metformin 2 days after any IV contrast dye load.
 - If no contrast dye is used perioperatively, medications containing metformin may be resumed without delay.
 - Please see [FDA statement](#) on use of metformin in patients with reduced kidney function.
- If glycemic control has been suboptimal, close follow-up with primary physician is recommended for healing and prevention of infection.

Insulin

- Resume intermediate-acting or long-acting insulin as previously scheduled.
- May need additional units of rapidly acting or short-acting insulin between completion of procedure and next regularly scheduled insulin.
 - Consider using sliding scale.
- For insulin pumps, resume usual basal rates and bolusing schedule once able to eat/drink.
- Check blood glucose frequently during the first 24 hours post-procedure or same-day surgery.

Inpatient Procedures

Glucose Targets

- Target for hospitalized patients is 140-180 mg/dl.
- For special populations such as post-operative cardiothoracic and neurosurgical patients, targets may be lower as determined by the managing medical team.

Glucose Monitoring

- Hourly for IV insulin infusion.
- **ICU patients:**
 - On admission.
 - Then Q1h X 4.
 - Then Q4-6h.
- **Non-ICU patients:**
 - Q6h for NPO patients.
 - Before meals if eating and at bedtime.
 - More frequently if recent hypoglycemia (within 24 hours).

Inpatient Medication Adjustments

Insulin

- Continue insulin infusion for 24 to 48 hours or until off inotropic agents / extubated.
- Basal long-acting insulin is required following discontinuation of insulin drip if the patient has type 1 diabetes or requires > 1 unit of insulin/hr.
 - Basal long-acting insulin should be initiated at least 2 hours prior to discontinuation of the insulin drip.
- Avoid sliding scale insulin regular monotherapy in most patients unless they:
 - Are NPO.
 - Are well-controlled.
 - Do not require basal insulin prior to surgery.

Other Medications

- Patients may resume home diabetes medications at discharge provided they are eating, stable, and close to discharge.
 - Patients should not resume home diabetes medications at discharge if glycemic control has been suboptimal or other contraindications exist.

To Speak to a Diabetes Specialist

- Pager # 7592, # 5234 for OSUWMC, 8 a.m.-5 p.m.
- Pager # 1821, # 2516 for OSU East, 8 a.m.-5 p.m.
- WebXchange for Attending on Diabetes Consults, 5 p.m.-8 a.m.

References

- Joshi GP, et al. (2010). Society for Ambulatory Anesthesia Consensus Statement on Perioperative Blood Glucose Management in Diabetic Patients Undergoing Ambulatory Surgery. *Anesthesia & Analgesia Journal*, 111(6):1378-87.
- Moghissi ES, et al. (2009). American Association of Clinical Endocrinologists and American Diabetes Association Consensus Statement on Inpatient Glycemic Control. *Diabetes Care*, 32(6):1119-31.

- Umpierrez GE, et al. (2012). Management of Hyperglycemia in Hospitalized Patients in Non-critical Care Setting: An Endocrine Society Clinical Practice Guideline. *Journal of Clinical Endocrinology and Metabolism*, 97(1):16-38.
- [Glucophage prescribing instructions](#)
- Bilotta F, Rosa G. (2010). Glucose management in the neurosurgical patient: are we yet any closer? *Current Opinion in Anesthesiology*, 23:539-543.
- Lipshutz AKM, Gropper M. (2009). Perioperative glycemic control: an evidence-based review. *Anesthesiology*, 110:408-21.

Quality Measures

- Patients with a current HbA1c (within 30 days).
- Accu-Checks performed before and after surgery as well as approximately hourly if case > 1 hour.
 - Monitored anesthesia care cases will be excluded.
- Procedures with two or more glucose measures > 250 mg/dl.

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Guideline Approved

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