

I. Preoperative Assessment for Elective Procedures

For patients with poorly controlled diabetes (HbA1c \geq 8), refer to PCP or endocrinologist for management to optimize glycemic control prior to surgery. Aim for HbA1c < 8.

II. Preoperative Home Medication Instructions for Patients with Diabetes and/or Hyperglycemia

Medication	Night Before Surgery	Day of Surgery**	
		Type I DM	Type II DM
Insulins			
<u>Basal Insulins (long acting)</u> Glargine, Basaglar, Semglee, Detemir, Degludec	80% of usual dose PM dose	80% of usual AM dose	80% of usual dose if patient uses morning only or twice daily basal therapy
Insulin/GLP1 Combinations (degludec/liraglutide, glargine/lixisenatide)	80% of usual dose PM dose	80% of usual insulin dose (Hold GLP1)	80% of usual insulin dose if patient uses morning only or twice daily basal therapy (Hold GLP1)
<u>Intermediate Acting or Pre-Mixed</u> NPH 70/30 75/25	80% of usual PM dose	80% of usual AM dose	50% of usual AM dose if BG \geq 120 mg/dL. Hold if BG < 120 mg/d
U-500	70% of usual PM dose		50% of usual AM dose
<u>Rapid or Short Acting</u> lispro, aspart, glulisine, regular	Usual dose		HOLD any meal bolus doses If on correction scale, treat BG > 180 mg/dl
Insulin Pump	Usual basal rate and boluses		75-100 % of usual basal rate; no boluses Check blood sugar q2h or sooner if symptoms of hypoglycemia experienced
Oral and Non-insulin Injectables			
<u>Sulfonylureas</u> glyburide, glipizide, glimepiride	Take with meals		HOLD
<u>Thiazolidinediones</u> rosiglitazone, pioglitazone	Take		
<u>Meglitinides</u> repaglinide, nateglinide	Take with meals		
<u>Alpha-glucosidase inhibitors</u> acarbose, miglitol	Take with meals		
<u>GLP-1 Receptor Agonists</u> exenatide, liraglutide, exenatide XR, albiglutide, dulaglutide, lixisenatide, semaglutide	Take if on "daily dosing" Consider holding a week prior to surgery if on "weekly dosing". Consider bridging with other anti-diabetic meds		
Pramlintide	Take before meals		
<u>DPP-IV inhibitors</u> sitagliptin, saxagliptin, linagliptin, alogliptin	Take		Take
Metformin	Take		May resume post procedure if diet resumed
<u>SGLT2 Inhibitors</u> canagliflozin, dapagliflozin, empagliflozin, ertugliflozin	**Discontinue for at least 3-4 days prior to surgery** - canagliflozin, dapagliflozin & empagliflozin: 3 days before surgery - ertugliflozin: 4 days before surgery		HOLD

****Day of Surgery:**

- If you have a glucose meter, check your blood sugar when you wake up and every 4 hours until you reach the hospital.
- **For symptoms of hypoglycemia or blood sugar less than 80 mg/dl while fasting:**
 - Drink 4 ounces of clear sugar-containing beverage such as apple juice or ginger ale or 15gm of chewable glucose tablets (read bottle for dosage instructions)
 - Check blood sugar in 15 minutes and repeat as necessary to get blood sugar greater than 80 mg/dl.
 - Notify RN of hypoglycemia and time of treatment upon arrival to hospital

III. Preoperative Management upon Hospital Arrival

A. Check capillary blood glucose (BG) level upon arrival to preoperative area if:

Patient with diabetes mellitus (DM)	Patient without known diagnosis of diabetes, with the following risk factors (take within 24 hours of surgery start time): <ul style="list-style-type: none"> ● Age > 45 <li style="text-align: center;">OR ● BMI > 30
<ul style="list-style-type: none"> A. Check BG every 2 hours and treat per Glycemic Control Guidelines (Table B) B. Confirm most recent diabetes medication/insulin dose and time taken 	<ul style="list-style-type: none"> ● If BG > 180 mg/dl, notify Anesthesia. <ul style="list-style-type: none"> ○ Check BG every 2 hours and treat per Glycemic Control Guidelines (see Table B) ○ Provide “Preoperative screening for hyperglycemia letter” to patient

B. Table B – Hospital Preoperative Glycemic Control Guidelines

- **Enter all insulin orders as “STAT”.** Lispro insulin will be available in Pyxis. Basal (intermediate or long-acting) insulin and insulin infusions will come from central pharmacy.
- **Patients with Insulin Pumps** – Continue 75-100% basal rate. Treat per Table B and C.
- **If BG < 150 mg/dL for fasting patients with diabetes receiving insulin,** consider infusing dextrose* at 5 gm/hr (e.g. D51/2NS at 100 ml/hr, D10W at 50 ml/hr)

* Sufficient glucose is recommended to prevent catabolism, starvation ketosis, and insulin-induced hypoglycemia.

Table B – Hospital Preoperative Glycemic Control Guidelines

BG Level	Initial Treatment	Ongoing Management
1. RN TO CONFIRM/OBTAIN ALL INITIAL INSULIN ORDERS WITH ANESTHESIA. 2. For patients with diabetes, confirm the most recent diabetes med/insulin dose and time taken. For insulin-dependent DM, give insulin per Table C-AM SQ insulin table if AM basal dose was not administered at home. Order STAT. 3. RN may continue ongoing treatment per insulin drip protocol or lispro correction scale.		
BG < 50	<ul style="list-style-type: none"> ● Start D51/2NS at 100 ml/hr ● Give 50ml (1 amp) D50W IVP 	<ul style="list-style-type: none"> ● Notify Anesthesia. ● Recheck BG every 15 min and treat accordingly until BG is ≥ 80 mg/dl. ● Once BG > 80 mg/dl, recheck BG in 1 hour ● Treat according to BG values on this table
BG 50-79	<ul style="list-style-type: none"> ● Start D51/2NS at 100 ml/hr ● Give 25ml (1/2 amp) D50W IVP 	
BG 80-139		<ul style="list-style-type: none"> ● Recheck BG in 2 hours ● If BG rises above 150, give lispro correction insulin per scale below.
BG 140-180 (Goal)	<p>If patient has diabetes:</p> <ul style="list-style-type: none"> ● For major surgery, critically ill patients or anticipated OR time > 2 hours, start insulin infusion per protocol ** <p>For all other patients, with or without DM, administer lispro correction scale prn</p>	<p>Insulin infusion:</p> <ul style="list-style-type: none"> ● Glucommander : Recheck BG per Glucommander directions ● Non-Glucommander: Recheck BG hourly until 3 consecutive BG results within 100-180 mg/dL, then every 2 hrs <p>Subcutaneous insulin:</p> <ul style="list-style-type: none"> ● Recheck BG in 2 hours ● DO NOT re-dose correction lispro insulin more frequently than every 2 hours ● If two lispro insulin doses given in previous 4 hours and BG > 180, consider starting insulin infusion per protocol**.
BG 181-300	<ul style="list-style-type: none"> ● For major surgery, critically ill patients or anticipated OR time > 2 hours, start insulin infusion per protocol** ● For all other patients with or without DM, administer lispro correction scale prn 	
BG > 300	<ul style="list-style-type: none"> ● Contact Anesthesia to start insulin infusion per protocol** ● Consider rescheduling elective procedures 	<ul style="list-style-type: none"> ● Recheck BG per protocol.

** Insulin protocols available include Glucommander insulin infusion or non-Glucommander insulin algorithm – see Preoperative Glycemic Control Order Set. In order to transition to Glucommander SubQ it is recommended to stabilize patients on the Glucommander insulin infusion for a minimum of 6 hours. If shorter time frames are desired, recommend using the non-Glucommander insulin infusion

Lispro Insulin Subcutaneous Correction Scale: **DO NOT give lispro insulin more frequently than every 2 hours**			
	BMI < 25	BMI 25-30	BMI > 30
Blood Glucose (mg/dl)	Lispro insulin Units		
< 150	0 unit	0 unit	0 unit
150-200	2 units	3 units	4 units
201-250	4 units	6 units	8 units
251-300	6 units	9 units	11 units
> 300	Notify Anesthesia and start insulin infusion		

C. Table C - AM Subcutaneous Insulin Dose (DO NOT GIVE IF ALREADY GIVEN IN AM PRIOR TO ARRIVAL)

	Home Insulin	Insulin (Subcutaneous) Dose to Administer		
		Type 2 Diabetes	Type 1 Diabetes	
Insulin Dependent DM	Once daily (PM) glargine/ detemir	None	None	+ lispro correction scale
	Once daily (AM) glargine/ detemir	Glargine 80% of AM dose	Glargine 80% of AM dose	
	Twice daily Glargine/ detemir	Glargine 80% of AM dose	Glargine 80% of AM dose	
	NPH	50% of usual AM dose if BG \geq 120 mg/dL. Hold if BG < 120 mg/dL	NPH 80% of AM dose	
	U-500	50% of usual AM dose	50% of usual AM dose	
	70/30 or 75/25	50 % of total AM dose as NPH if BG \geq 120 mg/dL. Hold if BG < 120 mg/dL	80% of total AM dose as NPH	
	Insulin pump*	75-100% basal rate, no pump boluses	100% basal rate; no pump boluses	

D. Non-Glucomander Insulin Infusion* – Use “Preoperative Glycemic Control” order set. Check BG hourly.

1. **Start insulin infusion** when BG is 180 mg/dL or greater.
2. Calculate **initial drip rate** using the following formula: **$[(BG-60) \times 0.03 = \text{drip rate}]$** , round to the nearest unit.
3. Ongoing drip management:

BG (mg/dl)	Insulin Infusion Titration	Ongoing Management/BG Monitoring
< 70	Turn off the drip. If awake give 25 ml D50W IVP. If obtunded, give 50 ml D50W IVP.	Recheck BG in 15 min. Repeat treatment if BG < 70 mg/dl. Recheck BG every 30 min until BG > 70 mg/dl then resume hourly BG checks. Restart infusion after BG > 120 mg/dl (decrease multiplier by 0.01)
70-99	Decrease multiplier by 0.01	<ul style="list-style-type: none"> • Infusion rate = $[(BG-60) \times \text{multiplier}]$, round to the nearest unit • Hourly BG checks
100-180	No change in multiplier	
> 180	Increase multiplier by 0.01	

* SMMC uses a different insulin infusion algorithm; refer to preoperative glycemic control order set.

E. Glucomander Insulin Infusion – Use “Glucomander Insulin Infusion ED/IP” order set in Epic. Provider to specify multiplier and goal BG range. Adjust infusion rate and check BG per Glucomander directions.

IV. Intraoperative Management (Select appropriate option A or B)
A. Non-Glucomander Insulin infusion*:

- **Infusions are recommended for all major surgery, critically ill patients, or surgery anticipated to last > 2 hours**
- If BG drops below 150 mg/dL, consider infusing dextrose for NPO patients with diabetes at 5 gm/hr (e.g. D51/2NS at 100 ml/hr, D10W at 50 ml/hr).
 1. **Start insulin infusion** when BG is 180 mg/dL or greater.
 2. Calculate **initial drip rate** using the following formula: **$[(BG-60) \times 0.03 = \text{drip rate}]$** , round to the nearest unit.
 3. Ongoing drip management:

BG (mg/dl)	Insulin Infusion Titration	Ongoing Management/BG Monitoring
< 70	Turn off the drip. If awake give 25 ml D50W IVP. If obtunded, give 50 ml D50W IVP.	Recheck BG in 15 min. Repeat treatment if BG < 70 mg/dl. Recheck BG every 30 min until BG > 70 mg/dl then resume hourly BG checks. Restart infusion after BG > 120 mg/dl (decrease multiplier by 0.01)
70-99	Decrease multiplier by 0.01	<ul style="list-style-type: none"> ● Infusion rate = $[(BG-60) \times \text{multiplier}]$, round to the nearest unit ● Hourly BG checks
100-180	No change in multiplier	
> 180	Increase multiplier by 0.01	

* SMMC uses a different insulin infusion algorithm; refer to preoperative glycemic control order set.

B. Glucomander Insulin Infusion – For new starts, specify multiplier and goal BG range. Adjust infusion rate and check BG per Glucomander directions.
C. Lispro correction scale:

- BG monitoring every 2 hours
- Do **NOT** give subcutaneous lispro insulin more frequently than every 2 hours
- Identify last dose if given in pre-admit or pre-op holding area

Lispro Insulin Subcutaneous Correction Scale:			
DO NOT give lispro insulin more frequently than every 2 hours			
	BMI < 25	BMI 25-30	BMI > 30
Blood Glucose (mg/dl)	Lispro insulin Units		
< 50	Give 50 ml (1 amp) of D50W; repeat BG/treatment every 10-15 min until BG > 80		
51-79	Give 25 ml (½ amp) of D50W; repeat BG/treatment every 10-15 min until BG > 80		
80-149	0 unit	0 unit	0 unit
150-200	2 units	3 units	4 units
201-250	4 units	6 units	8 units
251-300	6 units	9 units	11 units
> 300	Start insulin infusion		

V. Immediate Postoperative Management
A. Outpatient Procedures:

- a. If on insulin drip, stop infusion.
- b. Check BG upon arrival to PACU and every 2 hours for **all patients with DM and/or those patients with the following risk factors: BMI > 30 or age > 45)**
 - If BG < 70 mg/dl, give 25 ml (1/2 amp) D50W IVP and recheck in 15 minutes
 - If BG > 200 mg/dl, contact Anesthesia for additional orders.
- c. Medication instructions upon discharge:
 - i. Non-insulin diabetes meds may be resumed once the patient is eating. If eGFR is less than 30 ml/min, recommend holding metformin and having patients receive a follow-up serum creatinine/eGFR assessment prior to resuming metformin. Metformin should only be resumed if eGFR is greater than 30 ml/min.

- ii. For insulin:
 1. Resume intermediate-acting or long-acting insulin at the next scheduled dose. Resume prandial insulin once a patient eats. May need additional units of rapid-acting insulin until resumption of regularly scheduled insulin.
 2. For insulin pumps, continue basal rate and resume bolus doses once able to eat/drink.
 3. Check BG frequently during the first 24 hours post-procedure.
- iii. If glycemic control has been suboptimal, close follow-up with PCP is recommended.

2. Inpatient Procedures:

- a. Check BG upon arrival to PACU for **all patients with DM and/or those patients with the following risk factors: BMI > 30 or age > 45**. If new hyperglycemia (BG > 180 mg/dl) is identified, notify anesthesia.
 - Treat with correction scale dose:

Lispro Insulin Subcutaneous Correction Scale:			
DO NOT give lispro insulin more frequently than every 2 hours			
	BMI < 25	BMI 25-30	BMI > 30
Blood Glucose (mg/dl)	Lispro insulin Units		
< 150	0 unit	0 unit	0 unit
150-200	2 units	3 units	4 units
201-250	4 units	6 units	8 units
251-300	6 units	9 units	11 units
> 300	Notify Anesthesia and start insulin infusion		

- b. Ensure plan for postsurgical glycemic control is addressed with surgeon

i. Insulin infusion patients

1. Continue insulin infusion if:
 - a. Patient critically ill
 - b. Patient unstable with elevated BG levels > 200 mg/dl
2. Transition to scheduled subcutaneous basal insulin dosing + correction scale if:
 - a. Insulin-dependent DM (type 1 or 2)
 - b. Non-insulin-dependent type 2 DM with a mean infusion rate of ≥ 1 unit/hr
 - c. Stress hyperglycemia with mean infusion rate of ≥ 1.5 units/hr
 - d. Persistent hyperglycemia (BG > 180)

For patients on the Glucommander insulin infusion, enter the Glucommander Transition to SubQ Insulin order set if the patient meets criteria to transition. For patients on non-Glucommander insulin infusions:

- **Insulin-dependent DM:** Evaluate total daily insulin dose prior to admission. Use Glucommander SubQ Insulin orders custom dosing feature. Order basal insulin at $\leq 50\%$ of total daily dose. If eating, order $\leq 50\%$ of the remaining total daily dose as nutritional insulin (usually equally divided three times a day with meals).
 - **If insulin naïve,** use Glucommander SubQ insulin orders. Evaluate appropriate multiplier to start insulin dosing. Use basal/correction if NPO and basal/bolus/correction if the patient will be eating or **if anticipated to eat within 72 hours. Give 1st basal insulin dose 2 hours prior to stopping the infusion.**
3. **If not appropriate for basal insulin or if requirements for basal insulin are unknown,** stop insulin infusion and transition to blood glucose monitoring (use "Initiation of Glucose Monitoring" order set). This is suggested for:
 - a. Non-insulin-dependent type 2 DM with a mean infusion rate of < 1 unit/hr
 - b. Stress hyperglycemia with mean infusion rate < 1.5 units/hr
 - c. Well controlled DM on diet alone or single oral anti-diabetic medications

ii. Non-insulin infusion patients

1. Transition to glucose monitoring (use "Initiation of Glucose Monitoring" order set) and/or correction scale insulin alone if:
 - a. No previous history of diabetes and single isolated elevated BG value
 - b. Well controlled DM on diet alone or single oral anti-diabetic medications
 - c. Perioperative dose of dexamethasone and/or other corticosteroid given

2. Transition to Glucomander SubQ insulin orders if:
 - a. Insulin-dependent DM (type 1 or 2). Use the custom dosing feature to provide a similar total daily dose of insulin at home. Ensure basal insulin is provided at $\leq 50\%$ of total daily dose of insulin at home.
 - b. Non-insulin-dependent type 2 DM with BG > 180 x 2
 - c. Stress hyperglycemia with BG > 180 X 2.
3. Notify provider for BG < 70 or > 300 mg/dl.

VI. Postoperative Management

1. Glycemic goals: preprandial or fasting 100-140 mg/dl, random: less than 180 mg/dl
2. **Insulin therapy is the preferred inpatient treatment strategy.** Oral antidiabetic medications may be considered in the following scenarios:
 - **Metformin** may be restarted if patients take this prior to admission once diet is resumed
 - **Alogliptin +/- basal insulin + correction scale** may be initiated in patients with mild to moderate hyperglycemia (BG < 180, A1C < 8 and those not on insulin PTA)
 - Other formulary agents may be resumed close to or immediately prior to discharge if the patient is eating well without hypoglycemia and no other contraindications noted.
 - **Currently empagliflozin should be continued for HF and/or CKD only.** This agent should only be resumed if the patient is eating well and no other contraindications noted.
3. Initiate insulin orders via appropriate order set. *Inpatient Glycemic Control Guidelines located at end of order sets.*
 - Glu - Glucomander Insulin Infusion ED/IP
 - Glu - Glucomander DKA and HHS Insulin Infusion ED/IP
 - Glu - Glucomander Transition to Basal SubQ Insulin
 - Glu - Glucomander / Other Insulin Subcutaneous Initial Regimen (for first time insulin ordering)
 - Glu - Non Glucomander – Subcutaneous Regimen Adjustment (for adjusting insulin orders after initial orders placed for non-Glucomander regimens.
 - Glu - Glucomander Modify Orders (use if next basal, bolus, or correction orders need to be changed)
 - Glu - Initiation of Glucose Monitoring (to order BG to assess for insulin needs)
4. Sole use of correction scale insulin is discouraged due to increased rates of hyper- and hypoglycemia.
5. For type 1 DM, patients always require basal insulin even in fasting states to prevent ketoacidosis.
6. **For patients with insulin pumps,** may continue home insulin orders if the patient is able to operate the pump. Use Glucomander / Other Insulin Subcutaneous Initial Regimen, “other insulins” panel to order insulin pump and pharmacist consult to identify home insulin pump and dose settings. If a patient is unable to operate a pump, recommend stopping the insulin pump and making note of this in the chart. Ensure pump is disconnected, discontinue any active insulin pump orders and order either insulin infusion or subcutaneous basal/bolus insulin using the ‘Glucomander / Other Insulin Subcutaneous Initial Regimen order set.

VII. References

1. American Diabetes Association. Diabetes Care in the Hospital: Standards of Medical Care in Diabetes.. Diabetes Care 2022;45(Suppl. 1):S244-S253.
2. Moghissi ES, Korytkowski MT, DiNardo M et al. American Association of Clinical Endocrinologists and American Diabetes Association Consensus Statement on Inpatient Glycemic Control. Diabetes Care 2009; 32(6):1119-1131.
3. Korytkowski MT, Muniyappa R, Antinori-Lent K et al. Management of Hyperglycemia in Hospitalized Adult Patients in Non-Critical Care Settings: An Endocrine Society Clinical Practice Guideline. J Clin Endoc & Metab 2022;107:2101-2128.
4. Management of Diabetes Mellitus in Surgical Patients. Dagogo-Jack S, Alberti GM. Diabetes Spectrum 2002; 15:44-47.
5. Marks J. Perioperative Management of Diabetes. American Family Physician 2003;67:93-100.
6. Smiley DD, Umpierrez GE. Perioperative Glucose Control in the Diabetic or NonDiabetic Patient. Southern Med J 2006; 99(6):580-589.
7. Joslin Diabetes Center and Joslin Clinic Guideline for Inpatient Management of Surgical and ICU Patients with Diabetes. (2015, December 30). Retrieved from <http://www.joslin.org/docs/Inpatient-management-of-surgical-patients-with-diabetes-12-30-2015.pdf>
8. Billiodeaux ST, Samuelson CG, Willett O et al. Intraoperative and Postoperative Blood Glucose Concentrations in Diabetic Surgical Patients Receiving Lactated Ringer's Versus Normal Saline: A Retrospective Review of Medical Records. The Ochsner Journal 2014(1):175-178.
9. Abdelmalak BB. Anesthesiologist's Guide to Perioperative Glycemic Management. ASA Refresher Courses in Anesthesiology 2014;42(1):1-11.
10. Joshi GP, Chung F, Vann MA et al. Society of Ambulatory Anesthesia Consensus Statement on Perioperative Blood Glucose Management in Diabetic Patients Undergoing Ambulatory Surgery. Anesth Analg 2010;111(6):1378-87.
11. Sebranek JJ, Lugli AK, Coursin DB. Glycaemic Control in the Perioperative Period. British J of Anesth 2013;111(S1):i18-i34.
12. Peters A, Werner K. Perioperative Management of the Diabetic Patient. Exp Clin Endocrinol 1995;103:213-218.
13. Van MA. Perioperative Management of Ambulatory Surgical Patients with Diabetes Mellitus. Curr Opin Anaesthesiol 2009;22:718-724.
14. Joshi GP, Chung F, Vann MA et al. Society for Ambulatory Anesthesia Consensus Statement on Perioperative Blood Glucose Management in Diabetic Patients Undergoing Ambulatory Surgery. Anesthesia & Analgesia. 2010; 111(6):1378-87
15. Society of Hospital Medicine. Perioperative Settings – Glycemic Control Implementation Toolkit. Retrieved from http://www.hospitalmedicine.org/Web/Quality_Innovation/Implementation_Toolkits/Glycemic_Control/Web/Quality_Innovation/Implementation_Toolkit/Glycemic/Reliable_Interventions/Perioperative_Settings.aspx
16. Sudhakaran S, Surani SR. Guidelines for Perioperative Management of the Diabetic Patient. Surg Research and Practice 2015;2015:1-8.kk
17. Duggan E, Carlson K, Umpierrez GE. Perioperative Hyperglycemia Management: An Update. Anesthesiology 2017;126:547-60.
18. Sreedharan R, Khanna S, Shaw A. Perioperative Glycemic Management in Adults Present for Elective Cardiac and Non-cardiac surgery. Perioperative Medicine 12, 13(2023).
19. Crowley K, Scanail P, Hermanides, J et al. British Journal of Anaesthesia. April 13, 2023. Retrieved from <https://www.bjanaesthesia.org/action/showPdf?pii=S0007-0912%2823%2900128-9>