Inpatient glycemic control guidelines during surgery and Covid pandemic

Dr Mohamad Ahangar Davoodi
Pediatric Endocrinologist
Department of Pediatric, Arak University of Medical Sciences

Hyperglycemia management in hospitalized patients with COVID-19

Patients With Type 1 Diabetes Hospitalized for COVID-19 in the U.S.

- Compared with patients without diabetes, T1DM was associated with a 21% higher absolute risk of ICU/MV and a 5% higher absolute risk of mortality.
- Compared with T2DM, T1DM was associated with a 9% higher absolute risk of ICU/MV, but no difference in mortality.
- Higher risk of ICU/MV in patients with T1DM than in patients with T2DM was largely accounted for by the presence of DKA.

Diabetes Care 2021;44:1–9 | https://doi.org/10.2337/dc21-0604

Inpatient Hyperglycemia Management and COVID-19

- Inpatient hyperglycemia during this pandemic has been associated with worse outcomes.
- Clinical guidelines recommend maintaining glucose levels between 140 and 180 mg/dL (7.8–10.0 mmol/L) for most critically ill patients
- A target glucose range of 110–180 mg/dL (6.1–10.0 mmol/L) may be appropriate for most critically and noncritically ill patients.
- BG levels; 110_140 mg/dl may be reasonable for stable patients with mild disease without significant hypoglycemia and previous thight glycemic control.
- BG levels > 180 might be acceptable for patients with high risk of hypoglycemia or very labile and critical forms of disease (particularly postprandial continuous tube feeding) and who have limited life expectancy.

Diabetes Ther (2021) 12:121–132

Table 1 Hyperglycemia management in critically and noncritically ill patients with COVID-19

	Glycemic targets	Clinical situation		Insulin regimen	BG monitoring
Critically ill patients	140–180 mg/dL* (7.8–10.0 mmol/L)	Hemodynamically unstable Parenteral nutrition Unstable insulin requirements Corticosteroid therapy		Continuous intravenous insulin infusion	Every hour
		Hemodynamically stable Stable insulin requirements		Subcutaneous insulin Basal-correction or basal-bolus-correction	Every 4–6 h
Noncritically ill patients	110–180 mg/dL** (6.1–10.0 mmol/L)	T1D	Not oral intake	Basal-correction	Every 4–6 h[##]
		T2D on oral agents ± insulin	Oral intake	Basal-bolus-correction	Before meals and at bedtime[##]
		T2D on diet Unknown DM	Glycemia at admission < 180 mg/dL (10.0 mmol/L)	Correction insulin before meals or every 6 h[#]	Before meals and at bedtime or every 6 h[##]
			Glycemia at admission > 180 mg/dL (10.0 mmol/L)	Basal-bolus-correction	Before meals and at bedtime[##]

Inpatient Hyperglycemia Management and COVID-19

- Regarding ICU patients, the integration of computer-guided insulin infusion with CGM or further development of new automated insulin delivery systems may be ideal.

- A continuous intravenous insulin infusion and scheduled basalbolus correction insulin are the preferred regimens for glycemic control in critically and noncritically ill hospitalized patients, respectively.

Diabetes Ther (2021) 12:121–132

DETAILED TREATMENT GUIDANCE BG 200–250 mg/dL		
1.	**NO PRIOR KNOWN DIABETES or KNOWN DIABETES ON <2 ORAL AGENTS**	**MONITORING**
	• Check HbA_{1c} if none available in last 3 months	Check BG every 6 h
a	**Start sliding scale** regular insulin: moderate to high dose and escalate scale if BG >250 mg/dL	
b	**Add scheduled regular insulin every 6 h** if TF initiated (see above for regular insulin dosing based on eGFR and hourly TF rate) + scale	
c	**Add scheduled regular insulin if BG remains>250 mg/dL +** scale even if no TF initiated	
2.	**KNOWN DIABETES PRIOR TO ADMISSION**	Check BG every 6 h
	• Check HbA_{1c} if none available in last 3 months	
a	**T1DM** NPO: **add basal insulin glargine** ASAP (to **avoid DKA**): use 70% of home dose if eGFR >50 and 50% if eGFR <50 **+ scale**	
b	**T1DM on insulin pump and has supplies:** if feasible, continue basal insulin via pump (use increased temporary basal rate if needed); **rare use in ICU so calculate total basal as in a**	
c	**T1DM + TF:** continue basal insulin (to prevent DKA) and add **scheduled regular insulin for TF every 6 h** (guidance above based on eGFR and TF rate) + scale	
d	**T2DM NPO:** on regimen that included insulin prior to admission: start 25–50% basal dose + scale	
e	**T2DM on insulin PTA + TF:** start 25–50% basal dose and regular insulin for TF coverage every 6 h; see above for dose calculations + scale	

BG 200–250 mg/dL*: see details of treatment and titration in Table 2				
a	**START SLIDING SCALE REGULAR** insulin: moderate to high dose scale			**MONITORING**
b	**ADD SCHEDULED REGULAR INSULIN** every 6 h if uncontrolled with scale or if tube feeds started			BG check every 6 h
c	**ADD BASAL INSULIN GLARGINE for patients with the following:**			
	• T1DM (70% of home dose for eGFR >50 and 50% for eGFR <50 to **avoid DKA**)			
	• T2DM on home insulin (25–50% basal dose) or >2 drugs			
	• Uncontrolled glucose on regular insulin alone: use 0.1–0.3 units/kg daily (below)			
	• NPH may be appropriate basal for patients on steroids			
BG 250–350 mg/dL: START SCHEDULED SUBCUTANEOUS INSULIN				
		HIGH SENSITIVITY **No known diabetes, known DM with** renal failure (eGFR<30), insulin naive, mild disease*	**MODERATE SENSITIVITY** **Known DM,** renal failure (eGFR 30–50), intermediate disease course**	**LOW SENSITIVITY** **Known DM,** renal function (eGFR >50), steroids, severe disease***
Type of insulin		**Insulin dose (units/kg)**		
BASAL#	**Glargine daily: noon or 6 P.M.**	0.1 units/kg/day	0.15–0.2 units/kg/day	0.3 units/kg/day
BOLUS	**Scheduled regular insulin every 6 h**	**Approximate start doses (units/kg every 6 h); use clinical judgement**		
	No tube feeds	0.1	0.15	0.2
	Low rate tube feeds (≤25 cc/h)	0.1–0.125	0.1–0.15	0.2–0.25
	High rate tube feeds (≥25 cc/h)	0.15	0.2	0.3
SCALE	**Regular insulin every 6 h**	Moderate	Moderate	High
FOLLOW TRENDS IN INFLAMMATORY MARKERS: PROCALCITONIN, D-DIMER, hsCRP, AND TRIGLYCERIDES TO GUIDE IN UPWARD or DOWNWARD TITRATION OF INSULIN DOSE				

Basal-bolus insulin regimen

- insulin should be initiated at a dose of 0.4 units/kg/day.
- consider lower starting dose of 0.2 units/kg/day in elderly patients or those with liver or renal dysfunction.
- The initial dose can be higher, (e.g., 0.6 units/kg/day) in overweight/obese patients, or those who had a high pill burden before admission.
- achieve and maintain pre-meal glucose values of <140 mg/dl and post-meal glucose values of <180 mg/dl

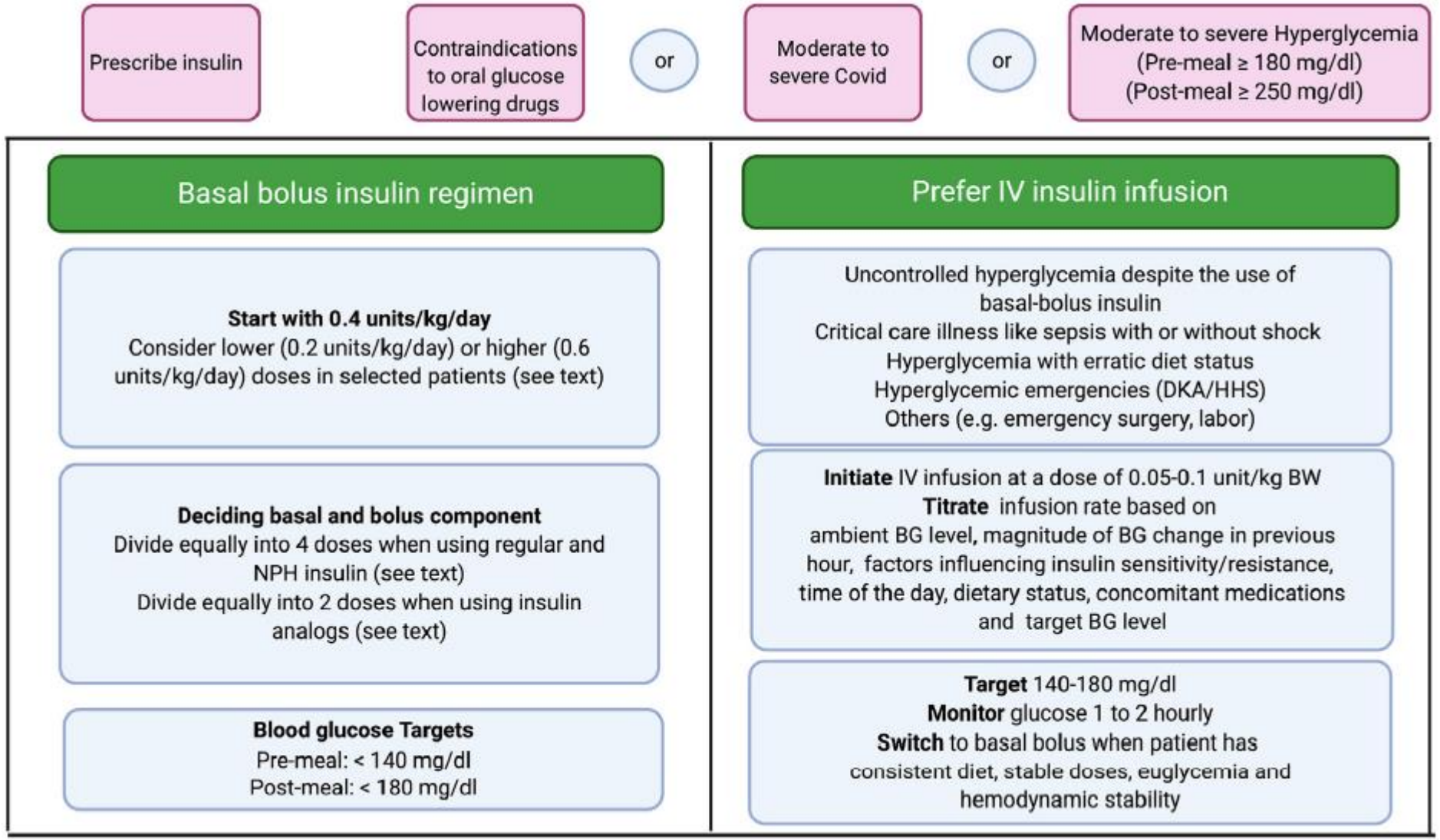
Diabetes & Metabolic Syndrome: Clinical Research & Reviews 15 (2021) 407e413

Patient on insulin infusion

- The infusion should be initiated at a low dose of 0.05_0.10 units/kg/hour, and the infusion rate should be titrated taking into account several factors.

- Once glucose ranges were within 200–300 mg/dL at lower hourly insulin drip rates, we would transition to subcutaneous insulin as soon as possible given the extenuating health care considerations described above.

Diabetes Volume 69, October 2020

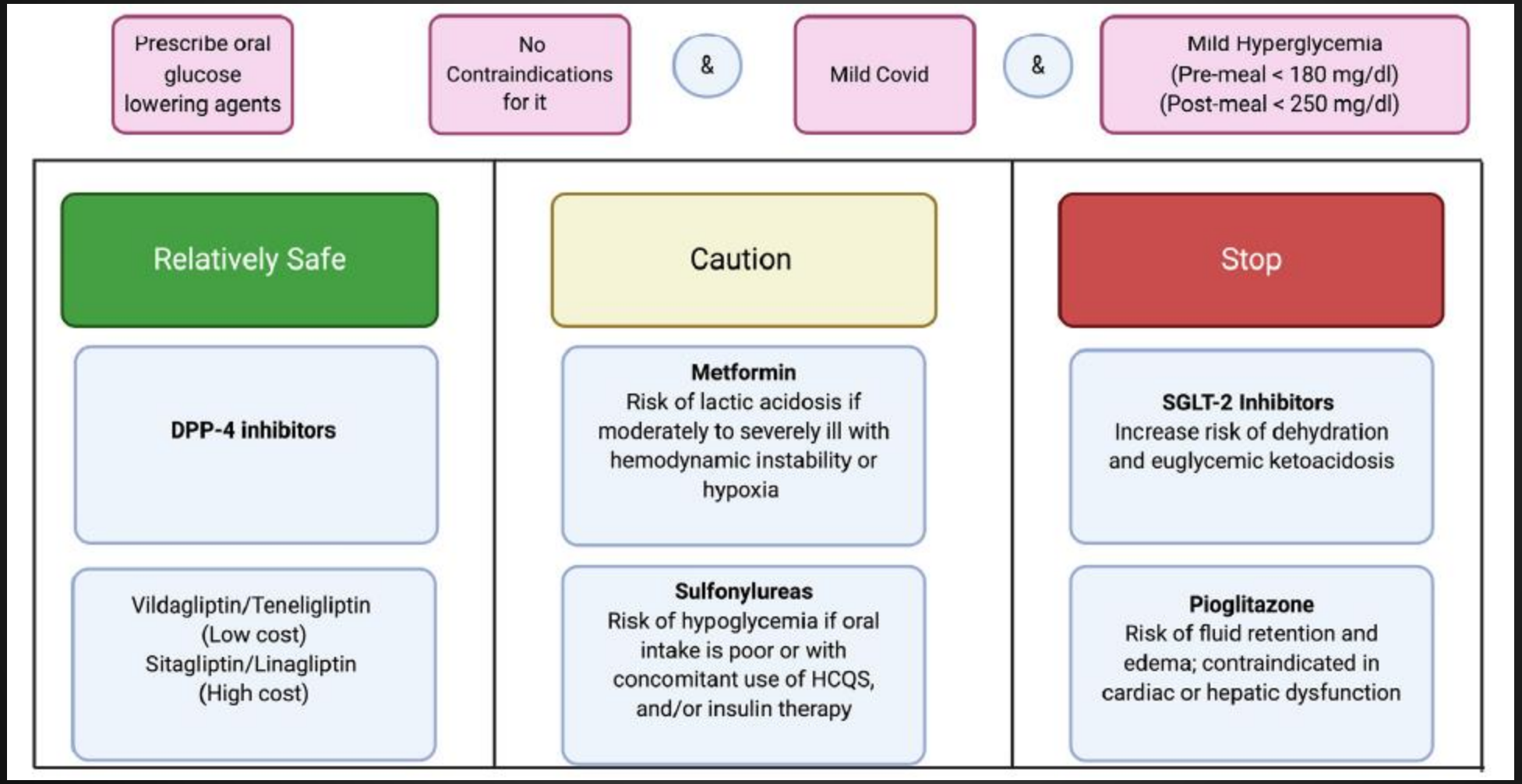

Prescribe insulin
Contraindications to oral glucose lowering drugs
or
Moderate to severe Covid
or
Moderate to severe Hyperglycemia
(Pre-meal ≥ 180 mg/dl)
(Post-meal ≥ 250 mg/dl)
Basal bolus insulin regimen
Start with 0.4 units/kg/day
Consider lower (0.2 units/kg/day) or higher (0.6 units/kg/day) doses in selected patients (see text)
Deciding basal and bolus component
Divide equally into 4 doses when using regular and NPH insulin (see text)
Divide equally into 2 doses when using insulin analogs (see text)
Blood glucose Targets
Pre-meal: < 140 mg/dl
Post-meal: < 180 mg/dl
Prefer IV insulin infusion
Uncontrolled hyperglycemia despite the use of basal-bolus insulin
Critical care illness like sepsis with or without shock
Hyperglycemia with erratic diet status
Hyperglycemic emergencies (DKA/HHS)
Others (e.g. emergency surgery, labor)
Initiate IV infusion at a dose of 0.05-0.1 unit/kg BW
Titrate infusion rate based on ambient BG level, magnitude of BG change in previous hour, factors influencing insulin sensitivity/resistance, time of the day, dietary status, concomitant medications and target BG level
Target 140-180 mg/dl
Monitor glucose 1 to 2 hourly
Switch to basal bolus when patient has consistent diet, stable doses, euglycemia and hemodynamic stability

Manage hyperglycemia in patients on glucocorticoids

- Even patients who have previously well-controlled blood glucose levels may require large doses of insulin (e.g., >2 units/kg/day) to achieve glycemic control following initiation of glucocorticoids.
- For patients receiving twice daily intermediate acting glucocorticoids (e.g., methylprednisolone), it is best to start a basal bolus insulin regimen.
- For patients receiving once a day morning dose of prednisolone: Basal (NPH) in morning and /or Bolus (regular) at lunch for support high blood glucose values in the afternoon and evening hours.
- uncontrolled hyperglycemia despite the use of basal-bolus regimen, the use of intravenous insulin infusion should be considered.

Diabetes & Metabolic Syndrome: Clinical Research & Reviews 15 (2021) 407e413

Management of patients T2DM



The Management of patients with T1DM During Surgery

Management objectives during surgery

- prevention of : hypoglycemia, excessive loss of fluids, and ketosis during anesthesia.
- management objectives during major elective or emergency surgery is to use IV infusions of glucose and insulin during the perioperative period.

Hyperglycemic preoperatively

- hyperglycemic preoperatively (serum glucose > 250 mg/dL), it is advisable to check for ketones prior to starting surgery.
- If significant ketosis is identified, surgery should be delayed (if possible) until the ketosis can be treated and resolved.
- Serum glucose levels should be followed every hour operatively and peri-operatively.

Basal insulin preoperative

- The nighttime dose of glargine or detemir insulin may provide sufficient basal insulin coverage for surgery in patients.
- A reduction in the glargine or detemir dose by 20% to 30% on the night before surgery should be considered in patients who have had a tendency to low prebreakfast plasma glucose levels.
- If NPH or Lente is used, one half of the morning dose is given before surgery.

Surgical emergencies

- rehydration and metabolic balance should be restored before the operation.
- One unit of regular insulin for every 2 to 4 g of exogenous glucose may be required because of elevated circulating concentrations of stress hormones or in insulin-resistant obese diabetic patients.
- The blood glucose concentration should be monitored at periodic intervals before, during, and after surgery.

Elective major operations

- should be performed first thing in the morning, and the glucose and insulin infusions should be started 2 hours or more before proceeding to the operating room.

- For elective surgeries; 1 unit of regular insulin is infused intravenously for each 4 to 6 g of administered glucose.

Surgery of short duration

- minor surgery :less than 2 hours, with/without sedation or anesthesia, able to eat by the next meal (within 2-4 hours): endoscopic biopsies, MRI scanning or insertion of grommets.
- on the morning of surgery, half of the usual morning dose of long-acting insulin is administered subcutaneously.

- the usual dose of rapid-acting insulin is omitted unless needed to correct hyperglycemia, and a maintenance IV infusion of the electrolyte and glucose solution is initiated if needed.

Insulin pump therapy

- in patients on insulin pump therapy who are undergoing short procedures, the CSII can be continued at the usual or slightly reduced overnight basal rate.

- Insulin pump-treated patients can also be maintained on CSII for major procedures, as long as the integrity of the infusion and infusion site is ensured.

- hyperglycemia can be corrected using the standard home ISF

IV Insulin drip during surgery

- IV insulin is typically started at a dose of 0.03 units/kg/hour for patients who are euglycemic at the time of surgery.
- For elective surgeries; 1 unit of regular insulin is infused intravenously for each 4 to 6 g of administered glucose.
- For surgical emergencies: 1 unit of regular insulin for every 2 to 4 g of exogenous glucose
- Concentrations of 120 to 150 mg/dL should be the goal.
- **Glycemic and metabolic goals for surgery (ISPAD)** in a range of 5 – 10 mmol/l (90 – 180 mg/dl)

Rate of insulin administration

Table 583-9 GUIDELINES FOR INTRAVENOUS INSULIN COVERAGE DURING SURGERY		
BLOOD GLUCOSE LEVEL (mg/dL)	**INSULIN INFUSION (U/kg/hr)**	**BLOOD GLUCOSE MONITORING**
<120	0.00	1 hr
121-200	0.03	2 hr
200-300	0.06	2 hr
300-400	0.08	1 hr†
400	0.10	1 hr†

Fluid therapy during surgery

- An infusion of 5% glucose and 0.45% or 0.9% saline solution with 20 mEq/L of potassium acetate is given at 1.5 times maintenance rate.

- If BG <70 mg/dl give bolus of IV 10% Dextrose 1-2ml/kg; recheck BG 15 minutes later and repeat if necessary.
- If still 70 mg/dl, stop IV insulin for 15 min and recheck and discuss with diabetes team.

Fluid therapy during surgery

- The rate at which IV fluids:
  1) maintenance 2) losses during surgery 3) other fluid deficits

- The IV insulin and glucose infusions can be continued until the patient is awake and capable of taking regular meals.

Thank you