

**JOSLIN DIABETES CENTER and JOSLIN CLINIC**  
**GUIDELINE for INPATIENT MANAGEMENT OF SURGICAL and ICU PATIENTS with DIABETES**  
**(Pre, Peri and Postoperative Care) 10/02/09**

The *Joslin Clinical Guideline for Inpatient Management of Surgical and ICU Patients with Diabetes* is designed to assist primary care physicians and specialists to individualize the care and set goals for adult, non-pregnant patients with diabetes who are undergoing surgery. This Guideline focuses on the unique needs of the patient with diabetes. It is not intended to replace sound medical judgment or clinical decision-making and may need to be adapted for certain patient care situations where more or less stringent interventions are necessary.

The objectives of the Joslin Clinical Guidelines are to support clinical practice and to influence clinical behaviors in order to improve clinical outcomes and assure that patient expectations are reasonable and informed. Guidelines are developed and approved through the Clinical Oversight Committee that reports to the Medical Director of Joslin Diabetes Center. The Clinical Guidelines are established after careful review of current evidence, medical literature and sound clinical practice. This Guideline will be reviewed periodically and modified as clinical practice evolves and medical evidence suggests.

Updates to this guideline are based upon the 2009 AACE/ADA Consensus Statement on Inpatient Glycemic Control.

**Surgery Algorithm For Patients with Existing Diabetes**

(The *Joslin Clinical Guideline for Inpatient Management of Surgical and ICU Patients with Diabetes* uses one formula for “splitting” the insulin; other reasonable formulae exist and are also acceptable.)

**Aim for Early Morning Booking**

**Day and Evening Prior to Surgery**

- Maintain usual meal plan and insulin dose (NPH, glargine, detemir, regular, aspart, glulisine, lispro, insulin via pump (CSII), 70/30, 75/25, or 50/50 insulin) **1C** or oral antidiabetes medications **1C**
- Check blood glucose (BG) at bedtime; if BG >180 mg/dl, instruct patient to take insulin according to subcutaneous algorithm or per individualized instructions **1A**; if hypoglycemic at bedtime or overnight, instruct patient to treat with glucose gel **1C**

**Morning of Surgery**

- If fasting after midnight, give ½ of the usual dose of intermediate (NPH) or 75-80% of the usual dose of long-acting (glargine or detemir) insulin
- Insulin pump (CSII) patients can continue usual basal rate **1B**
- Non pump users should not use rapid or short-acting insulin **1A**
- Omit oral antidiabetes medication **1A**
- Omit exenatide or pramlintide **1A**
- If the patient usually takes morning pre-mixed insulin (70/30, 75/25, 50/50) and is NPO, the optimal regimen would be to give ½ of the NPH component of the usual dose of premixed insulin and no rapid or short-acting insulin. **1B**
- Check BG every 2 hours before and during surgery **1C**; insulin pump patients (CSII) can maintain basal rate during surgery **1B** or be changed to IV insulin infusion **1A** or subcutaneous injections to maintain blood glucose target. **1A**

**Maintenance of Hydration**

- During surgery the patient should receive maintenance IV fluids without dextrose (e.g. LR or NS or ½ NS rather than D5LR). **2C**
- If an insulin infusion is required, D5W at 40 ml/hr or D10W at 20 ml/hr should be started to provide adequate substrate. Patients receiving insulin infusion should receive at least 50 g glucose/24 hours. **1C**

Major Surgery	Non-Major Surgery			
E.g., chest or abdominal cavity, LE bypass, transplant, spinal or brain surgery requiring general anesthesia, total hip or knee replacement, surgery anticipated to be >4 hours	BG <80 mg/dl ↓ Give at least 100 ml D10W IV or 25 – 50 ml (1/2 – 1 amp) of D50 ↓ Check BG in 15-30 min. <b>1C</b>	BG 80-100 mg/dl ↓ Begin D5W at 40 ml/hour or D10 W at 20 ml/hour ↓ Check BG in 1 hour <b>1C</b>	BG 101-180 mg/dl ↓ Continue to monitor BG every 2 hours <b>1C</b>	BG >180 mg/dl ↓ Begin IV insulin (See Pre, Intra and Post Operative IV Insulin Infusion Algorithm pg. 3) or subcutaneous insulin algorithm pg 2 <b>1B</b>

## Postoperative Management

- Check BG when patient returns to post-anesthesia unit **1B**; base frequency on BG during surgery **1C**
- Administer insulin according to subcutaneous algorithm or insulin infusion algorithm **1A**
- Use maintenance IV fluids without dextrose (e.g. ½ NS rather than D5W ½ NS). If on subcutaneous insulin no additional IV dextrose is required if the patient is not malnourished or in a severely catabolic state. If on an insulin drip, substrate must be provided as constant dextrose infusion (e.g. D5W @ 10-40 ml/hr). **1C**

**Patient able to tolerate at least 50% of prescribed diet?**

<p><b>YES</b></p> <p>Resume previous insulin regimen or oral antidiabetes medication (check serum creatinine before resuming metformin). <b>1C</b></p>	<p><b>NO</b></p> <p>Continue IV or subcutaneous insulin based on clinical judgment. <b>1C</b> Consider insulin infusion if blood glucose remains &gt;180 mg/dl. <b>1B</b></p>
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### Pre, Intra and Post-Operative Subcutaneous Short-Acting Insulin Algorithm for Patients with Known Diabetes or Newly Discovered Hyperglycemia Non-Critically Ill

#### This algorithm can be used:

- To supplement an insulin regimen already in place
- For patients previously on oral antidiabetes medications
- For patients with hyperglycemia without a diagnosis of diabetes. For patients without a diagnosis of diabetes who are normoglycemic prior to surgery, there is no evidence to support a specific frequency of monitoring glucose during surgery. Certain major surgical procedures such as cardiovascular and transplant surgery are associated with hyperglycemia and warrant frequent blood glucose monitoring during and after surgery.

#### Monitor glucose level and administer insulin: **1A**

- For glucose level >180 mg/dl, check hourly **1C**; if no improvement in glycemic control, consider insulin dosing according to next higher weight class. **1C** (see chart below)
- Every 4-6 hours if using regular insulin (short-acting) **1C**
- Every 2-4 hours if using aspart, glulisine, or lispro (rapid-acting) **1C**

	Weight Class I (<175 lbs/80 kg)	Weight Class II (175-220 lbs/81-99 kg)	Weight Class III (>220 lbs/100 kg)
<b>BG (mg/dl)</b>	<b>Insulin Units (subcut)</b>	<b>Insulin Units (subcut)</b>	<b>Insulin Units (subcut)</b>
≤180	0 unit	0 unit	0 units
181-200	1 unit	2 units	4 units
201-250	2 units	4 units	6 units
>250	Begin insulin infusion	Begin insulin infusion	Begin insulin infusion

## Pre, Intra and Post Operative IV Insulin Infusion Algorithm

### Decision to initiate IV insulin:

- If BG >180 mg/dl twice intra-operatively **1B**
- If BG >180 mg/dl twice postoperatively for cardiothoracic surgery **1B**
- If BG >180 mg/dl twice in intensive care units in non-cardiothoracic cases **1B**

A number of well-validated insulin infusion protocols have been shown to work effectively. Two sample algorithms are provided on pages 4 and 5: one designed to target BG levels of 100-180mg/dl for the non-critically ill patient, the other to target BG levels of 140-180 mg/dl for the critically ill patient.

- If BG <180 mg/dl, begin D5W at 40 ml/hr or D10W at 20 ml/hr. Maintenance IV fluids without dextrose (e.g. LR or ½ NS or NS) will be added to this in accordance with the patient's volume requirements. For prevention of ketosis, in most individuals, 50g/24 hours of glucose is generally recommended **1C**.

Calculating the Initial Insulin Dose		
If BG >180 mg/dl, give stat dose of IV insulin, 0.1 units/kg body weight.		
For patients having major surgery, larger starting doses can be given, and initiate an hourly rate of total daily dose of insulin divided by 24.		
For patients who have never been on insulin, begin with 0.02 units/kg body weight/hr.		
For patients on total parenteral nutrition (TPN), insulin infusion is <b>in addition to</b> insulin currently administered in the TPN solution.		
Alternative Initial Dose		
Blood glucose (mg/dl)	Regular Insulin (bolus)	Regular Insulin (IV infusion per hour)
181-200	No Bolus	2 units
201-250	3 units IV	2 units
251-300	6 units IV	3 units
301-350	9 units IV	3 units
>350	10 units IV	4 units



**Check BG Hourly**

**See Infusion Algorithm pages 4 and 5**

## Insulin Infusion Algorithm for Critically Ill Intraoperative and Medical ICU Patients (Target BG 140-180 mg/dl)

**Insulin dose adjustments using this algorithm do not replace sound medical judgment.**

<b>&lt;100</b>	Hold drip and give ½ - 1 amp 50% glucose and check BG every 30 minutes until >140 mg/dl and then re-initiate drip at 50% previous rate							
<b>Current BG level (mg/dl)</b>	<b>Previous Blood Glucose (mg/dl)</b>							
	<b>&lt;100</b>	<b>100-140</b>	<b>141-180</b>	<b>181-200</b>	<b>201-250</b>	<b>251-300</b>	<b>301-400</b>	<b>&gt;400</b>
<b>101-140</b>	↓ rate by 1 unit/hr	↓ rate by 25% or 0.5 units/hr*		↓ rate by 50% or 2 units/hr*			↓ rate by 75% or 2 units/hr*	
<b>141-180</b>	No Change				↓ rate by 50% or 2 units/hr*			
<b>181-200</b>	↑ rate by 1 unit/hr	↑ rate by 0.5 units/hr		↑ rate by 25% or 1 unit/hr*	No Change	↓ rate by 25% or 2 units/hr*		
<b>201-250</b>	↑ rate by 25% or 2 units/hr*			↑ rate by 25% or 1 unit/hr*			↑ rate by 1 unit/hr	No Change
<b>251-300</b>	↑ rate by 33% or 2.5 units/hr*		↑ rate by 25% or 1.5 units/hr*	↑ rate by 25% or 1 unit/hr*	↑ rate by 1 unit/hr	↑ rate by 1.5 units/hr	↑ rate by 25% or 2 units/hr*	No Change
<b>301-400</b>	↑ rate by 40% or 3 units/hr*							
<b>&gt;400</b>	↑ rate by 50% or 4 units/hr*							

- **\*Whichever is greater change**



This algorithm assumes hourly BG checks during insulin dose titration.



- If BG in desirable range (140-180 mg/dl) for 4 hours, decrease frequency of BG checks to every 2 hours while BG stays in target.
- If experiencing unexplained hypoglycemia or hyperglycemia, investigate and correct causative factors.
- If there is any significant change in glycemic source (i.e., parenteral, enteral or oral intake), expect to make insulin adjustment.



### Common reasons to discontinue insulin infusion:

- Patient tolerating at least 50% of normal oral intake or enteral feedings
- Clinically appropriate to transfer patient to a unit that does not do insulin infusions
- Patient on stable regimen of TPN with most of insulin already in TPN solution



### Two hours before discontinuing insulin infusion, initiate alternative glycemic management:

- For patients with type 1 diabetes or those with type 2 diabetes previously controlled on insulin: If NPO, initiate basal subcutaneous insulin (glargine, detemir or NPH) at 80% of the insulin administered over the previous 24 hours by insulin infusion. If the patient is taking more than 50% of usual oral or enteral intake, give 50% of insulin dose as basal insulin based on previous 24 hours of insulin infused or 0.25 units/kg and initiate pre-meal bolus and correction dose to maintain BG in target. Another alternative is to resume pre-hospital insulin regimen. Insulin pump patients can resume pump use based on hospital policy.
- For patients with type 2 diabetes previously treated with oral antidiabetes agents: If patient had good diabetes control previous to hospitalization, a return to oral agent therapy may be considered based on postoperative clinical status; if pre-hospital control was inadequate, plan for discharge on subcutaneous insulin.

## Insulin Infusion Algorithm for Non-Critically Ill Patients (Target BG 100-180 mg/dl)

**Insulin dose adjustments using this algorithm do not replace sound medical judgment.**

Some evidence suggests a higher incidence of hypoglycemia using these lower glucose targets. There is disagreement among experts about the degree of glycemic control needed to decrease morbidity and mortality while avoiding severe hypoglycemia.

< 100	Hold drip and give 1 amp 50% glucose and check BG every 30 minutes until >100 mg/dl and then re-initiate drip at 50% previous rate							
Current BG level (mg/dl)	Previous Blood Glucose (mg/dl)							
	< 100	100-140	141-180	181-200	201-250	251-300	301-400	>400
100-180	No change			↓ rate by 0.5 units/hr	↓ rate by 50% or 2 units/hr*		↓ rate by 75% or 2 units/hr*	
181-200	↑ rate by 1 unit/hr	↑ rate by 0.5 units/hr		No change		↓ rate by 50% or 2 units/hr*		
201-250	↑ rate by 25% or 2 unit/hr*	↑ rate by 1.0 units/hr	↑ rate by 0.5 unit/hr			No change	↓ rate by 25% or 2 units/hr*	
251-300	↑ rate by 25% or 2 units/hr*		↑ rate by 25% or 1 unit/hr*				↑ rate by 1 unit/hr	No Change
301-350	↑ rate by 33% or 2.5 units/hr*		↑ rate by 25% or 1.5 units/hr*	↑ rate by 25% or 1 unit/hr*	↑ rate by 1 unit/hr	↑ rate by 1.5 units/hr	↑ rate by 25% or 2 units/hr*	No Change
351-399	↑ rate by 40% or 3 units/hr*							
> 400	↑ rate by 50% or 4 units/hr*							

\*Whichever is greater change

↓  
This algorithm assumes hourly BG checks during insulin dose titration.

- If BG in desirable range (100-180 mg/dl) for 2-3 hours can decrease frequency of BG checks to every 2 hours while BG stays in target.
- If experiencing unexplained hypoglycemia or hyperglycemia, investigate and correct causative factors.
- If there is any significant change in glycemic source (i.e., parenteral, enteral or oral intake), expect to make insulin adjustment.

↓  
**Common reasons to discontinue insulin infusion:**

- Patient tolerating at least 50% of normal oral intake or enteral feedings
- Clinically appropriate to transfer patient to a unit that does not do insulin infusions
- Patient on stable regimen of TPN with most of insulin already in TPN solution

↓  
**Two hours before discontinuing insulin infusion, initiate alternative glycemic management:**

- For patients with type 1 diabetes or those with type 2 diabetes previously controlled on insulin: If NPO, initiate basal subcutaneous insulin (glargine, detemir or NPH) at 80% of the insulin administered over the previous 24 hours by insulin infusion. If the patient is taking more than 50% of usual oral or enteral intake, give 50% of insulin dose as basal based on previous 24 hours of insulin infused or 0.25 units/kg and initiate pre-meal bolus and correction dose to maintain BG in target. Another alternative is to resume pre-hospital insulin regimen. Insulin pump patients can resume pump use based on hospital policy.
- For patients with type 2 diabetes previously treated with oral antidiabetes agents: If patient had good diabetes control previous to hospitalization, a return to oral agent therapy may be considered based on postoperative clinical status; if pre-hospital control was inadequate, plan for discharge on subcutaneous insulin.

## Glossary

<b>AACE</b> – American Association of Clinical Endocrinologists	<b>ICU</b> – Intensive care unit	<b>NS</b> – Normal saline
<b>ADA- American Diabetes Association</b>	<b>IV</b> – Intravenous	
<b>BG</b> – Blood glucose	<b>LE</b> – Lower extremity	<b>Subcut</b> - subcutaneously
<b>CSII</b> - continuous subcutaneous insulin infusion	<b>LR</b> – Lactated Ringers	<b>TPN</b> – Total parenteral nutrition
<b>DM</b> – Diabetes mellitus	<b>NPO</b> – Nothing by mouth	

Approved by Clinical Oversight Committee on 10/23/09

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