JOSLIN DIABETES CENTER and JOSLIN CLINIC
GUIDELINE for INPATIENT MANAGEMENT OF SURGICAL and ICU PATIENTS
(Pre, Peri and Postoperative Care) 4/30/07

The Joslin Clinical Guideline for Inpatient Management of Surgical 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 Diabetes 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 Joslin Clinic 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.

SURGERY ALGORITHM: FOR PATIENTS WITH EXISTING DIABETES

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

Aim for Early AM Booking

Day and Evening Prior to Surgery:

- Usual diet and insulin dose (NPH, glargine, detemir, regular, aspart, glulisine, lispro, inhaled insulin, insulin via pump, 70/30, 75/25, or 50/50 insulin) or oral antihyperglycemic medications
- Check blood glucose (BG) at bedtime; if BG > 180 mg/dl, instruct patient to take insulin according to subcutaneous algorithm or per individualized instructions; if hypoglycemic at bedtime or overnight, instruct patient to treat with glucose gel

Morning of Surgery

- If fasting after midnight, give ½ usual dose intermediate (NPH) or full dose long-acting (glargine or detemir) insulin; no change in basal rate for insulin pump patients; no rapid or short-acting insulin; no oral antihyperglycemic medication; no exenatide or pramlintide
- If the patient is coming in from home on pre-mixed insulin (70/30, 75/25, 50/50) and is NPO, less than ½ of the usual morning dose is recommended to avoid hypoglycemia. The optimal regimen would be to give ½ the usual morning dose as NPH insulin.
- If not fasting, give usual dose of insulin
- Check BG every 2 hours before and during surgery; insulin pump patients can maintain basal rate during surgery or be changed to IV insulin infusion or subcutaneous injections to maintain blood glucose target.

Maintenance of Hydration

- During surgery the patient should receive maintenance IV fluids without dextrose (e.g. LR rather than D5LR).
- If an insulin infusion is required, D5W at 40 ml/hr or D10W at 20 ml/hr should be started to provide adequate substrate. This is not required if adequately managed with subcutaneous insulin.
- Patients receiving insulin infusion should receive at least 50 g glucose/24 hours.

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 ↓ **Start IV Insulin** (*See Insulin Infusion Algorithm pg. 2*)	BG < 80 mg/dl ↓ Give at least 100 ml $D_{10}W$ IV or 25 – 50 ml (1/2 – 1 amp) of D_{50} ↓ Check BG in 15-30 min.	BG 80-100 mg/dl ↓ Begin D_5W at 40 ml/hour or D10 W at 20 ml/hour Check BG in 1 hour	BG 101-150 mg/dl ↓ Continue to monitor BG every 2 hours	BG > 150 mg/dl ↓ Begin IV insulin (*See Insulin Infusion Algorithm pg. 2*) **or** subcutaneous insulin algorithm

Postoperative Management

- Check BG when patient returns to postanesthesia unit; base frequency on BG during surgery
- Administer insulin according to subcutaneous algorithm or insulin infusion algorithm

- 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).

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

YES ↙ Resume previous insulin regimen or oral antihyperglycemic medication (check serum creatinine before resuming metformin).

↘ **NO** Continue IV or subcutaneous insulin based on clinical judgment. Consider insulin infusion if blood glucose remains > 180 mg/dl.

PRE, INTRA and POST-OPERATIVE SUBCUTANEOUS SHORT-ACTING INSULIN ALGORITHM

This algorithm can be used a) to supplement an insulin regimen already in place, b) for patients previously on oral antihyperglycemic medications or c) 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:
  - For glucose level >180 mg/dl, check hourly; if no improvement in glycemic control, consider insulin dosing according to next higher weight class
  - Every 4-6 hours if using regular insulin (short-acting)
  - Every 2-4 hours if using aspart, glulisine, lispro or inhaled insulin (rapid-acting)

	Weight Class I (<175 lbs/80 kg)	**Weight Class II (175-220 lbs/81-99 kg)**	**Weight Class III (>220 lbs/100 kg)**
BG (mg/dl)	**Insulin Units (subcut)**	**Insulin Units (subcut)**	**Insulin Units (subcut)**
<150	0 unit	1 unit	2 units
150-180	1 unit	2 units	4 units
181-200	2 units	4 units	6 units
>200	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 >150 mg/dl twice intra-operatively
- If BG >110 mg/dl twice postoperatively for cardiothoracic surgery
- If BG > 150 mg/dl twice in intensive care units in non-cardiothoracic cases

A number of well-validated insulin infusion protocols have been shown to work effectively. There is little data to show any one is superior. Two sample algorithms are provided on pages 3 and 4: one designed to target BG 101-150 mg/dl and another to target BG 80-110 mg/dl.

- 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

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: initiate an hourly rate of total daily dose of insulin divided by 24
For patients who have never been on insulin, 0.02 units/kg body weight/hr
For acute surgical patients, e.g., cardiothoracic or transplant, higher starting doses may be necessary
For patients on total parenteral nutrition (TPN), insulin infusion is **in addition to** insulin currently administered in the TPN solution

Alternative Initial Dose		
Blood glucose (mg/dl)	**Regular Insulin (bolus)**	**Regular Insulin (infusion per hour)**
151-200	No Bolus	2 units IV
201-250	3 units IV	2 units IV
251-300	6 units IV	3 units IV
301-350	9 units IV	3 units IV
>350	10 units IV	4 units IV

↓

Check BG Hourly

RECOMMENDED

INSULIN INFUSION ALGORITHM FOR INTRAOPERATIVE and MEDICAL ICU (Target BG 101 – 150 mg/dl)

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

***Whichever is greater change** **Previous Blood Glucose (mg/dl)**

Current Blood Glucose (mg/dl)

	<60	**60-80**	**81-100**	**101-150**	**151-200**	**201-250**	**251-300**	**301-400**	**>400**
<60	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								
60-80	Hold drip and check BG every 30 minutes until >100 mg/dL and then re-initiate drip at 50% previous rate								
81-100	↓ rate by 1unit/hr	No change	↓ rate by 25% or 0.5 units/hr*		↓ rate by 50% or 2 units/hr*			↓ rate by 75% or 2 units/hr*	
101-150	No Change					↓ rate by 50% or 2 units/hr*			
151-200	↑ 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*		
201-250	↑ rate by 25% or 2 units/hr*				↑ rate by 25% or 1 unit/hr*			↑ rate by 1 unit/hr	No Change
251-300	↑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
301-400	↑ rate by 40% or 3 units/hr*								
>400	↑ rate by 50% or 4 units/hr*								

↓

This algorithm assumes hourly BG checks during insulin dose titration.

↓

If BG in desirable range (101-150 mg/dl) for 4 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

↓

<u>Two hours</u> before discontinuing insulin infusion, initiate alternative glycemic management:

- **For type 1 DM and type 2 DM 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 type 2 DM previously on oral antihyperglycemic 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 poor, plan for discharge on subcutaneous insulin.

OPTIONAL

INSULIN INFUSION ALGORITHM FOR LOWER GLUCOSE TARGETS (Target BG 80 – 110 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. The following meets the AACE recommendations.

***Whichever is greater change** **Previous Blood Glucose (mg/dl)**

Current Blood Glucose (mg/dl)

	<60	60-80	81-110	111-150	151-200	201-250	251-300	301-400	>400
<60	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								
60-80	Hold drip and check BG every 30 minutes until >100 mg/dl and then re-initiate drip at 50% previous rate								
81-110	No change				↓ rate by 0.5 units/hr	↓ rate by 50% or 2 units/hr*		↓ rate by 75% or 2 units/hr*	
111-150	↑ rate by 1 unit/hr	↑ rate by 0.5 units/hr			No change		↓ rate by 50% or 2 units/hr*		
151-200	↑ rate by 1 unit/hr		↑ rate by 0.5 units/hr	↑ rate by 1 unit/hr		No Change	↓ rate by 25% or 2 units/hr*		
201-250	↑ rate by 25% or 2 units/hr*			↑ rate by 25% or 1 unit/hr*				↑ rate by 1 unit/hr	No Change
251-300	↑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
301-400	↑ rate by 40% or 3 units/hr*								
>400	↑ rate by 50% or 4 units/hr*								

↓

This algorithm assumes hourly BG checks during insulin dose titration.

↓

If BG in desirable range (81-110 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

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<u>Two hours</u> before discontinuing insulin infusion, initiate alternative glycemic management:

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- **For type 2 DM previously on oral antihyperglycemic 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 poor, plan for discharge on subcutaneous insulin.

Glossary		
AACE – American Association of Clinical Endocrinologists	**IV** – Intravenous	**NS** – Normal saline
BG – Blood glucose	**LE** – Lower extremity	**Subcut -** subcutaneously
DM – Diabetes mellitus	**LR –** Lactated Ringers	**TPN** – Total parenteral nutrition
ICU – Intensive care unit	**NPO** – Nothing by mouth	

Approved by Clinical Oversight Committee on 4/30/07.

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