

Diabetes Mellitus and the Surgical Patient

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Diabetes Mellitus

- Common disorder with increasing incidence
- 5% of the North American population
- In general, diabetics are in poorer health leading to more surgical procedures
- 50% chance that a diabetic will require surgery in their lifetime

Diabetes Mellitus

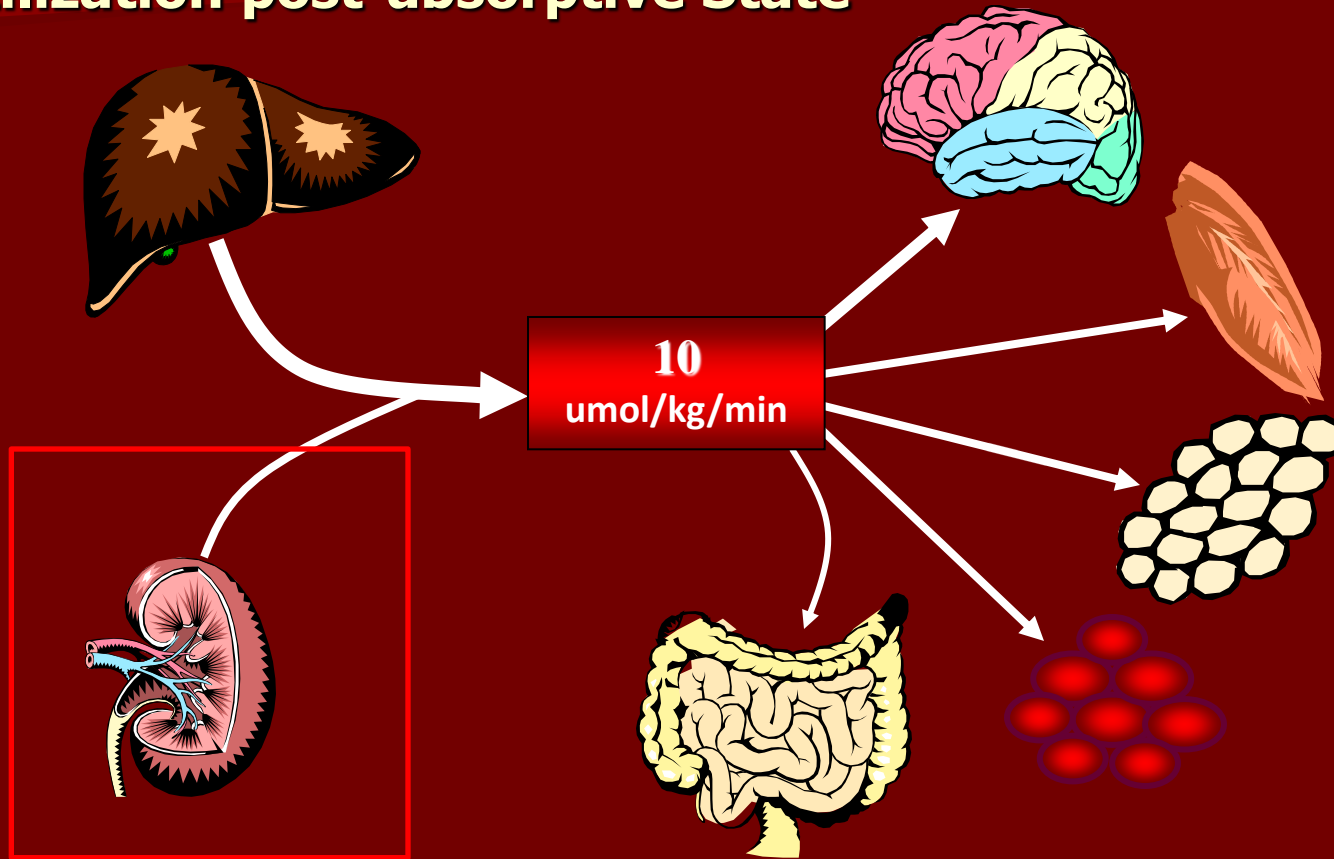
- Diabetic microvascular and macrovascular complications lead to an increased need for surgery
- Surgery to address:
 - Renal failure and its treatment
 - Cataracts and retinal disease
 - Foot ulcer
 - PVD
 - CAD

Diabetics and Surgery

- Requires understanding of CHO metabolism
- Liver plays central role
- Insulin
 - Major anabolic hormone
 - Most active in “Fed” state (glycogenesis/lipogenesis)
 - Stimulates glucose uptake into fat and muscle
 - Promotes protein anabolism

Glucose Homeostasis in the Fasting State

Illustrated by the glucose production and utilization post-absorptive State



Diabetes and Surgery

- Insulin deficiency or resistance mimicks the “Fasting” state
 - Glycogen/fat/protein are catabolized to maintain energy production
 - Glucagon promotes gluconeogenesis and glycogenolysis in liver
 - Cortisol promotes protein breakdown
 - Catecholamines cause lipolysis and glycogenolysis

Diabetes and Surgery

- Energy homeostasis maintained at expense of body stores
- Surgery and anesthesia are major stresses that influence glucose homeostasis
- Counter regulatory hormones cause insulin resistance and hyperglycemia

Diabetes and Surgery

- General Anesthesia suppresses endogenous insulin secretion
- Vasoactive substances can exert anti-insulin effects
- In DM, insulinopenia leads to hyperglycemia, increased osmolality, hypovolemia, abnormal electrolytes, and in extreme DKA or HONK

Diabetes and Surgery

- Other concerns beyond insulin:

- CAD
- Autonomic neuropathy
- Peripheral neuropathy
- Diabetic nephropathy
- Wound healing
- Infections

Preoperative Assessment

■ Historical features

- Cardiac history and current symptoms
- Other medical conditions
- Long term diabetic complications
- Baseline glycemic control
- Hypoglycemic events?
- Current diabetic treatment
- Type of surgery
- Type of anesthetic planned

Preoperative Assessment

- Examination

- Lab tests:

- Glucose +/- Hgb A1C
- Renal function
- Electrolytes

- ECG

- Other



Preoperative Assessment

- Aim for optimal glycemic control (depending on urgency of OR)
- Goal of blood sugar < 11.0
- Benefits
 - Normal fluid and electrolyte balance
 - Reduced insulin resistance
 - Improved endogenous Beta cell responsiveness (T2DM)
 - Decreased hepatic gluconeogenesis
 - Improved WBC function and wound healing

Preoperative Management

- General goal to avoid marked hyperglycemia and avoid significant hypoglycemia
- Procedures should be arranged as early in the day as possible

Preoperative Management

■ T2DM on diet therapy:

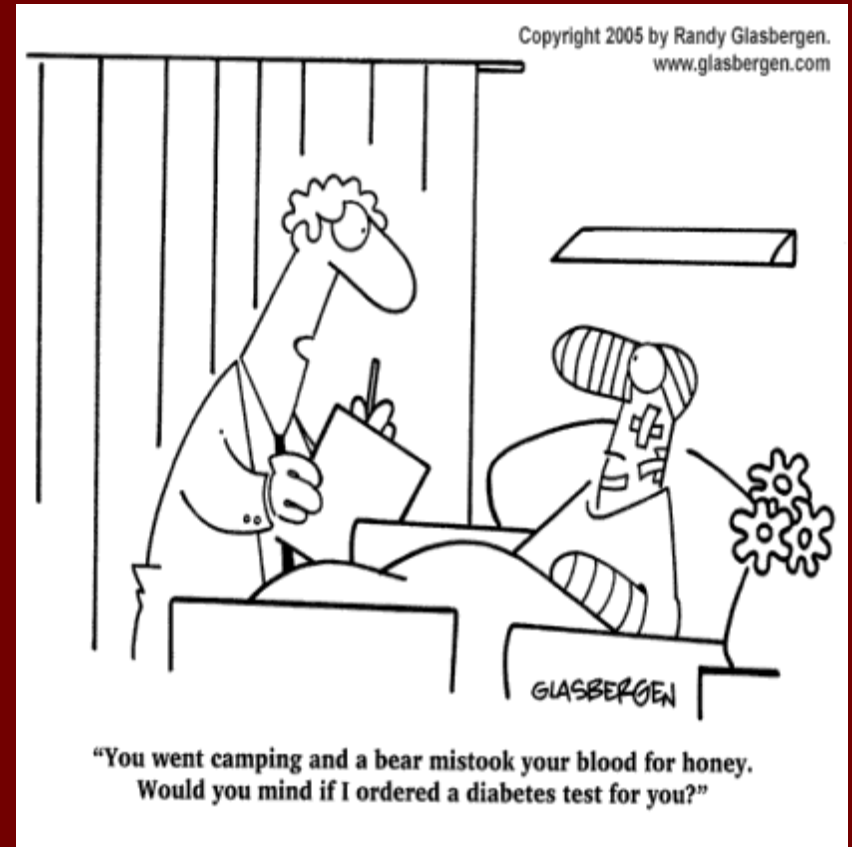
- NPO for procedure
- Usually do not require any specific therapy preop
- Supplemental SC short acting insulin (regular or lispro) if required for BS > 11.0

■ T2DM on OHG:

- Last dose of OHG night before OR
- NPO for procedure
- +/- IV glucose pre op
- Supplemental SC short acting insulin (regular or lispro) if required for BS > 11.0

Preoperative Management – DM on insulin

- Typically can continue SC insulin perioperatively
- Preop evening dose of insulin decreased to $\sim 2/3$ to prevent am hypoglycemia
- May require preop IV glucose or insulin



Preoperative Management – DM on insulin

- **Short, early morning OR, breakfast only delayed:**
 - Delay usual morning insulin
 - Administer insulin only after OR when and able to eat

DM on Insulin:

- **Morning procedure, breakfast to be missed, lunch to be eaten:**
 - Once daily insulin
 - 2/3 of am insulin (intermediate acting)
 - BID insulin
 - 1/2 of am insulin as intermediate acting

DM on Insulin

■ Morning procedure, breakfast and lunch meals to be missed:

- Once daily insulin
 - 1/2 of total am insulin as intermediate acting insulin
- BID insulin
 - 1/3 of total am insulin as intermediate acting insulin
- Insulin Pump
 - Continue basal infusion rate

DM on Insulin

- **Procedure later in the day:**
 - Need to avoid metabolic changes of starvation
 - Overall give less insulin and IV glucose infusion
 - Once daily insulin
 - 1/2 of total am insulin as intermediate acting
 - BID insulin
 - 1/3 of total am insulin as intermediate acting
 - Insulin pump
 - Continue basal infusion rate

DM on Insulin

- **Long and complex procedures:**
 - IV insulin infusion
 - Safe
 - Start the am of OR
 - Short $\frac{1}{2}$ life allows for precise glucose management
 - SC insulin
 - Marked variability of glucose concentrations

Patient Instructions for People with Diabetes (Surgical Day Care Diabetes Management Protocol)

BEFORE your operation

If you have diabetes and take pills for this condition, DO NOT TAKE THIS MEDICATION the morning of your surgery. Bring your diabetes pills to the hospital with you.

If you have diabetes and take insulin for this condition, DO NOT TAKE YOUR INSULIN the morning of your surgery. Bring your insulin to the hospital with you.

If you have diabetes and use an insulin pump, no changes to the pump basal rates are usually needed. If you are using a pump and are concerned about your blood sugar control during your operation, contact your diabetes care team BEFORE your surgery day. Bring a new insertion set with you in case a tubing change is needed.

If you test your blood sugar levels at home, test as usual the morning of surgery. Please bring your blood glucose meter and testing equipment to the hospital with you, in case you need to check your blood sugars on the way home.

AFTER your operation

You may resume your usual diabetes routine after surgery.

If you only take pills for your diabetes management once a day in the morning, you may resume your routine the first day after surgery.

If you have a blood glucose meter and have been testing your blood sugars at home, please test your blood before each meal and at bedtime for 24 hours after your surgery.

Please keep a record of these readings. We will be calling you the day after your surgery to see how you are doing and will ask you for these readings.

After 24 hours, you may resume your usual blood sugar testing.

If you feel "low" (weak, sweaty, dizzy, light-headed, shaky, confused or irritable) or have a blood sugar reading under 4 mmol/L, then have one of the following:

½ to ¾ cup (190 mls) of apple or orange juice, or regular (non-diet) pop

or

3 tsps of sugar or honey

or

3 glucose tablets

Retest your blood sugar in 15 minutes. If your blood sugar remains under 4 mmol/L, retreat with juice, sugar, or your own glucose tablets.

You should begin to feel better in 15 minutes.

If you have repeated "lows" or blood sugars over 20 mmol/L, contact your usual health care provider or seek emergency medical treatment if required.



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PHYSICIAN'S ORDERS
ORDONNANCES MÉDICALES

Allergies/Reactions

Substances/Reactions

☐ none known-aucune connue

☐ none known-aucune connue

DIABETES MANAGEMENT PROTOCOL FOR DAY SURGERY PATIENTS - PRE-OPERATIVE ORDERS

PRE-ADMISSION VISIT

- Measure capillary or serum blood glucose
If blood glucose > 11 mmol/L, discuss risks/benefits of glycemic control
- Consult endocrinology/Internal Medicine for patients using sc insulin infusion pump
- Instruct patient that on the morning of surgery he/she should:

_____ Hold oral diabetes medications

_____ Hold morning insulin

PRE-OPERATIVE MANAGEMENT DAY OF SURGERY

- Measure capillary blood glucose on admission

For patients treated with insulin sc:

- Initiate IV 5% dextrose in water at 100mL/hr
- Administer sc, one half (1/2) of patient's usual total morning insulin with longer acting insulin on admission.

Dose: _____ units of

☐ Humulin N,

Other insulin orders:

☐ Novolin ge NPH, OR

☐ Humulin L

(dose, type, route)

MANAGEMENT OF HYPOGLYCEMIA (Capillary blood glucose less than 4 mmol/L)

- IV direct 25 mL dextrose 50%
- Reassess capillary blood glucose in 15 minutes then q1h
 - If still < 4 mmol/L repeat IV direct 25 mL dextrose 50% and notify Anesthesiology

MANAGEMENT OF HYPERGLYCEMIA

- Administer planned dose of insulin on admission (ordered above) PLUS
- If capillary blood glucose between 12-15 mmol/L give one dose Insulin Aspart (Novorapid) 2 units sc
- If capillary blood glucose between 15.1-20 mmol/L give one dose Insulin Aspart (Novorapid) 3 units sc
- If capillary blood glucose > 20 mmol/L give one dose Insulin Aspart (Novorapid) 4 units sc
- Reassess capillary blood glucose in 1 hour. If not decreasing, notify Anaesthesiology

DO NOT REPEAT INSULIN ASPART (NOVORAPID) WITHIN 4 HOURS

Date: _____ Time: _____ Physician's/Médecin printed/imprimé: _____ Signature: _____
Date (noté-notifié): _____ Time: _____ Processed by-Traité par: _____ Signature (Nurse-Infirmière): _____

Postoperative Management

- The pre operative DM regimen may be reinstated once the patient is eating well
- SC sliding scales are often used to bridge the gap but
 - Cause wide fluctuations in glucose control
 - Not physiologic
 - If used should be individualized
 - Should supplement a basal regimen

Postoperative Management - Insulin

- Restart insulin at modified dose if required
- Supplement with SC sliding scale with meals
- For patient on IV insulin, continue until eating well and ensure overlap with SC insulin
- Never leave T1DM without insulin – risk for DKA

Postoperative Management - OHG

■ Metformin

- Contraindicated in severe renal impairment
- Avoid in conjunction with IV contrast

■ Sulfonylureas

- Can induce sig and prolonged hypoglycemia
- Avoid or modify in erratic or poor PO intake
- Deterioration in renal function can increase risk of hypoglycemia

■ Thiazolidinediones

- Associated with fluid retention
- Avoid in advanced CHF



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PHYSICIAN'S ORDERS
ORDONNANCES MÉDICALES
Diabetes Management Protocol
Protocole pour la gestion du diabète

Allergies/Reactions

Substances/Reactions

☐ none known-aucune connue

☐ none known-aucune connue

POST-OPERATIVE ORDERS

POST-OPERATIVE MANAGEMENT

- Measure capillary blood glucose on arrival to phase 1 recovery then q4h and at discharge
- D/C IV when drinking well
- If patient not drinking well or not able to tolerate oral carbohydrates, notify Anaesthesiology

For patients treated with insulin and remaining in hospital over supertime

- If patient drinking well and able to tolerate oral carbohydrates give ½ the dose of usual supper time insulin

OR _____

MANAGEMENT OF HYPOGLYCEMIA (Capillary blood glucose less than 4 mmol/L)

If not tolerating fluids

- Initiate IV 5% dextrose in water at 100 mL/hr
- IV direct 25 mL dextrose 50%
- Reassess capillary blood glucose in 15 minutes then q 1h until discharge
 - If still < 4 mmol/L repeat IV direct 25 mL dextrose 50% and notify Anaesthesiology

If tolerating fluids po

- Give 125 mL of juice or 180 mL of non diet/regular gingerale, or 3 teaspoons/packets sugar in ½ cup water
- Reassess capillary blood glucose in 15 minutes and q 1h until discharge
 - If still < 4 mmol/L, retreat as above and retest in 15 minutes
- Notify Anaesthesiology if capillary glucose remains less than 4mmol/L

MANAGEMENT OF HYPERGLYCEMIA

- If capillary blood glucose between 12-15 mmol/L give one dose Insulin Lispro (Humalog) 2 units sc
- If capillary blood glucose between 15.1-20 mmol/L give one dose Insulin Lispro (Humalog) 3 units sc
- If capillary blood glucose > 20 mmol/L give one dose Insulin Lispro (Humalog) 4 units sc
- Reassess capillary blood glucose in 1 hour. If not decreasing, notify Anaesthesiology

DO NOT REPEAT INSULIN LISPRO (HUMALOG) WITHIN 4 HOURS

Date:	Time-Heure:	Physician's-Médecin printed-imprimé:	Signature:
Date (noted-notée):	Time-Heure:	Processed by-Traité par:	Signature (Nurse-Infirmière):

Postoperative Concerns

- TPN/Enteral Feeding
- Glucocorticoids
- Cardiac complications
- Poor Wound Healing
 - DM associated with increased frequency of wound infections
 - Collagen formation, phagocytic activity, chemotaxis and adherence of granulocytes adversely affected by hyperglycemia

Postoperative Concerns

- Postop infections
 - Impaired phagocytosis and Ab response
- Autonomic neuropathy
 - HR/BP, may have unpredictable response to surgical stress
- Peripheral neuropathy
 - Higher risk of pressure ulcers, skin necrosis
- Diabetic nephropathy
 - Challenging fluid and electrolyte balance
- Diabetic gastroparesis
 - May cause severe postop nausea and vomiting

- **Beyond avoidance of marked hyperglycemia and hypoglycemia, the optimal perioperative glucose targets are unclear**
- **Diabetes guideline bodies recommend glycemic targets of between 110 and 180 mg/dL (6.1 to 10 mmol/L) for noncritically ill hospitalized patients**
- **The American Diabetes Association (ADA) has endorsed a target glucose range for the perioperative period of 80 to 180 mg/dL (4.4 to 10 mmol/L)**

Evidence for “Tight” Glycemic Control

- Continuous IV infusion to achieve glycemic control 4.5-6.0 in postop patients that require ICU, mechanical ventilation (NEJM 2001)
- IV insulin intraop for Cardiac surgery to achieve blood sugar b/w 5-11.0 (Ann Thoracic Surg 1999)
- Perioperative glycemic levels b/w 5-11.0 in most other surgical situations (Consensus, CDA)

HYPOGLYCEMIA:

Cutoff value: glucose level ≤ 70 mg/dL (3.9 mmol/L)

- Avoiding hypoglycemia
- Virtually impossible for the sedated patient to sense
- Signs are difficult to detect
- Administer IV dextrose (25 g) and repeat blood glucose measurements in 5 to 10 minutes

Emergency procedures

■ T1DM:

- IV insulin infusion through a reliable IV access

■ T2DM:

- Blood glucose >250 mg/dL : IV insulin infusion or subcutaneous insulin

Emergency procedures

- *For long procedures, an insulin infusion is preferred*
- Patient on long-acting basal insulin once daily
- Continuous infusion of short- or rapid-acting insulin (insulin pump):
 - 1- Continued IV insulin infusion
 - 2- Additional corrective subcutaneous insulin

Conclusions

- DM is a common chronic condition with a significant subset of complications
- A condition requiring an increased number of surgical procedures
- Perioperative management is complex
- Patients are at risk for increased morbidity and mortality without adequate preop optimization and vigilant postop follow up

