Diabetes Mellitus, Hyperglycemia & Hypoglycemia for Hospitalized Patients in 2023

- **2023 Adult Hospital Medicine Bootcamp**
- **September 23, 2023**
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Disclosure

I have no relevant relationships with ineligible companies to disclose within the last 24 months.

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Learning Objectives

At the end of this session, participants should be able to:

- Review current literature regarding glycemic targets & insulin dosing with focus on non-ICU hospitalized patients, incorporating special populations (corticosteroids, ESRD/CKD, peri-operative)
- Discuss non-insulin therapies
- Recognize the importance of hypoglycemia
- **Choose dosing regimens based on patient population & nutritional status**

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A Bedtime Story…

- **Setting:** University Medical Center, Big Town, USA
- **Scenario:** 0500, last admission of the night, 10 previous admissions, all tucked in for the night
- **Patient:** 75-year-old male with past medical history of diabetes mellitus on 70/30 insulin 15 units BID, chronic kidney disease (CKD), who presents with altered mental status and acute kidney injury on CKD.

You admit the patient, putting orders in for his home insulin dose (15 units BID "70/30") with a "now" dose.

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- 0700: Day team arrives.
- 0730: RN call to Daytime PA-C: “Are you taking over care for this patient? The overnight RN gave him 15 units upon arrival to the floor at 0500 and his blood sugar was 200 then. His AM dose is due at 0800. Do you want me to give it? His blood sugar is 179. Also, he will get SSI correction per protocol.”
- Daytime PA-C: “Yes, give it.”
- RN: “Errr, are you sure? That is 2 doses of insulin in a short time period.”
- Daytime PA-C: “Yes, I’m sure, give the insulin.”

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- 0900: Daytime PA-C hears rapid response called overhead
- Arrives to find her new patient “unresponsive”
- Blood sugar on arrival is 35.

This story is real. It happened to me.

WHY?

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For Non-ICU Hospitalized Patients: ***Is there a target?***

- Hyperglycemia is defined as any **BG > 140 mg/dL**
- Target: BS 140-180 mg/dL in critically and non-critically ill patients
- **Glycemic targets should be modified according to clinical status:**
  - For patients with terminal illness, limited life expectancy, or at high risk for hypoglycemia, a higher target range < 200 mg/dl is ok
  - Tighter control (BS 110-140) ok if can be achieved w/o hypoglycemia

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Admission: Where do I start?

- **All patients:** blood glucose (BG) test upon admission
  - *Check A1C (if BG > 140/diabetic and not checked in the last 3 months)*
- **Discontinue** oral agents and **initiate** insulin in most patients
- Nurse-initiated hypoglycemia protocol (BG < 70)
- **Monitor** patients w/ DM or BG > 140 mg/dl with bedside POC for 24-48 h
  - If BG > 140, continue POC
  - **Initiate insulin therapy if BG persistently > 180 mg/dL**
- **Avoid** sliding scale insulin (SSI) monotherapy (more on this later)
- **POC schedules:**
  - Before meals and bedtime in patients who are eating/bolus tube feeds
  - q4-6h in patients who are NPO or getting continuous enteral feeding
  - q30min-2h in patients receiving intravenous insulin

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How should I dose insulin?

- **All DM1 & most DM2 = scheduled basal insulin**
- Estimate total daily dose (TDD) insulin*:
  - Malnourished, elderly (>65)**, CKD, ESRD, ESLD
    - 0.2-0.3 units/kg
    - 0.1 units/kg or DDP-4 inhibitor alone or DPP-4 + basal can be safe alternative in elderly pts
  - Normal-weight patients, incl. Type I DM
    - 0.4 units/kg
  - Overweight
    - 0.5 units/kg
  - Obese, high-dose steroids, insulin resistance
    - 0.6 units/kg

If patient on insulin at home, can use home dose as starting point…

****Elderly are especially at risk for hypoglycemia****

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How should I dose insulin?

- **NPO or clear liquids**
  - Basal: 50% TDD, nutritional: none, SSI if needed
- **Eating meals**
  - Basal: 50% TDD, nutritional: 50% TDD / 3 meals, SSI if needed
- **Continuous TFs**
  - Basal: continue prior, if none, use 5 units NPH/detemir q12h or 10 units glargine q24h
  - Nutritional: 1 unit/10 grams carbs in TF formula
  - Correctional: q6h regular insulin or q4h with rapid-acting insulin
- **Bolus TFs**
  - Basal: continue prior or 50% TDD; nutritional: 1 unit/10-15 grams carbs prior to feeding
- **Parenteral nutrition (add to bag if requiring > 20 units/day)**
  - Regular insulin to TPN – 1 unit/10 g carbs, continue SSI

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Adjust q1-2 days based on glucose trends; decrease by 20% if hypoglycemia

How do I transition from Continuous Insulin Infusion to SC Insulin?

- Use the average infusion rate over the preceding six to eight hours & multiply by 24 to determine the predicted requirement for the next day.
- Patient is likely to improve and have reduced insulin requirements, thus further reduce daily estimate to 60-80 percent of calculated dose.
- This value can be used as the total daily requirement if they were receiving significant nutritional support in the ICU (TPN or tube feeds) or the basal amount with nutritional layered over time as oral intake increases
- Continue intravenous insulin infusion:
  - For at least 1 hour after SC rapid-acting or regular insulin
  - For at least 2-4 hours after SC intermediate-acting or long-acting insulin is given.

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Special Populations

- **Steroid-induced hyperglycemia**
  - Monitor with bedside POC for at least 24-48 h after initiation of steroids; if BG > 140 mg/dl, continue POC testing
  - Initiate insulin if persistent hyperglycemia (BG > 180)
  - Prednisone (peak action 4-8 hours) – can use intermediate acting insulin (NPH), or if dexamethasone or multi-dose (longer acting) – use basal/prandial/correctional
  - Post-prandial hyperglycemia is common
- CKD
- Perioperative

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Special Populations

- Steroid-induced hyperglycemia
- **CKD**
  - High risk for hypoglycemia
  - A1C values are often unreliable
  - Many patients stop needing insulin as CKD progresses
  - Dose insulin at 0.2-0.3 units/kg
- Perioperative

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Special Populations

- Steroid-induced hyperglycemia
- CKD
- **Perioperative**
  - Target glucose in perioperative period: 80-180 mg/dL
  - Withhold oral hypoglycemic agents the morning of surgery and give half of NPH dose or 60–80% doses of a long-acting analog or pump basal insulin.
  - Monitor blood glucose at least every 4–6 h while NPO and dose with SSI
  - Moderate peri-op target of BG < 180 mg/dL is a/w lower risk of stroke & mortality
  - No benefit found w/ strict control (BG < 140 mg/dL) (non-critically ill)
  - In general surgery patients, basal-bolus insulin has been a/w better glycemic control and lower rates of perioperative complication

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CGM

- *Continuous Glucose Monitoring – what do you think?*

**Has not been approved for inpatient use by FDA*
Used more during COVID pandemic
Early data suggest benefit in glycemic control and outcomes

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SGLT2 inhibitors

- Sodium–glucose cotransporter 2 (SGLT2) inhibitors should be avoided in cases of severe illness, in people with ketonemia or ketonuria, and during prolonged fasting and surgical procedures.
- SGLT2 inhibitors not recommended for routine inpatient use for DM
- May be considered for the treatment of people with type 2 diabetes who have or are at risk for heart failure.
- FDA recommends that SGLT2 inhibitors should be stopped 3 days before scheduled surgeries (4 days in the case of ertugliflozin).

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What about DDP4 and GLP agonists?

- Society of Hospital Medicine recommendations
  - DDP-4 inhibitors (saxagliptin) + basal in some studies has shown to be safe.
  - Discontinue saxagliptin and alogliptin in patients who develop heart failure.
  - GLP1 agonists (Ozempic, Trulicity) need more studies

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A Note on Sliding Scale Insulin Monotherapy

- Retrospective study released in 2021
  - Included 44 U.S. hospitals: 41% of noncritically ill, hyperglycemic patients received SSI monotherapy
  - Retrospective chart review of 8000 patients with T2DM
- Primary outcome was T2DM patients achieving glycemic control (defined at BG > 70 but < 180 mg/dL)
- Most (86%) achieved this goal with SSI monotherapy; suggesting a role in patients with mild hyperglycemia who are not critically ill

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SSI - SHM

- Initial therapy with correction insulin only may be appropriate in patients with type 2 diabetes who:
  - are well controlled (HbA1c <7% or normal BG values) with only diet or a low dose-oral agent
  - have mild hyperglycemia and
    - are NPO on no nutritional replacement
    - are on new or tapering steroids
    - hypoglycemic risk factors including but not limited to end-stage liver or kidney disease, elderly patients or
    - those with an unknown drug overdose

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Hypoglycemia

- Level 1 hypoglycemia BS < 70 mg/dL
- Level 2 BS < 54 mg/dL (neuroglycopenic s/s begin)
- Level 3 is defined as any episode resulting in severe cognitive impairment/physical functioning that requires assistance from another person, regardless of BS level
- Episodes of severe hypoglycemia constitute an independent cardiovascular risk factor, increased LOS, & higher mortality both during and after admission

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Discharge

- Tailored discharge plan
- Initiate oral anti-diabetics 1-2 days prior to discharge
- Follow up visit w/in 1 month of discharge
- If glucose control not optimal, follow up in 1-2 weeks
- AHRQ recommends DC plans include:
  - Medication Reconciliation
  - Discharge communication to outpatient providers
    - Medication changes, discharge summary
  - Nutrition habits, DM education, identification of who will follow DM after discharge, sick-day management

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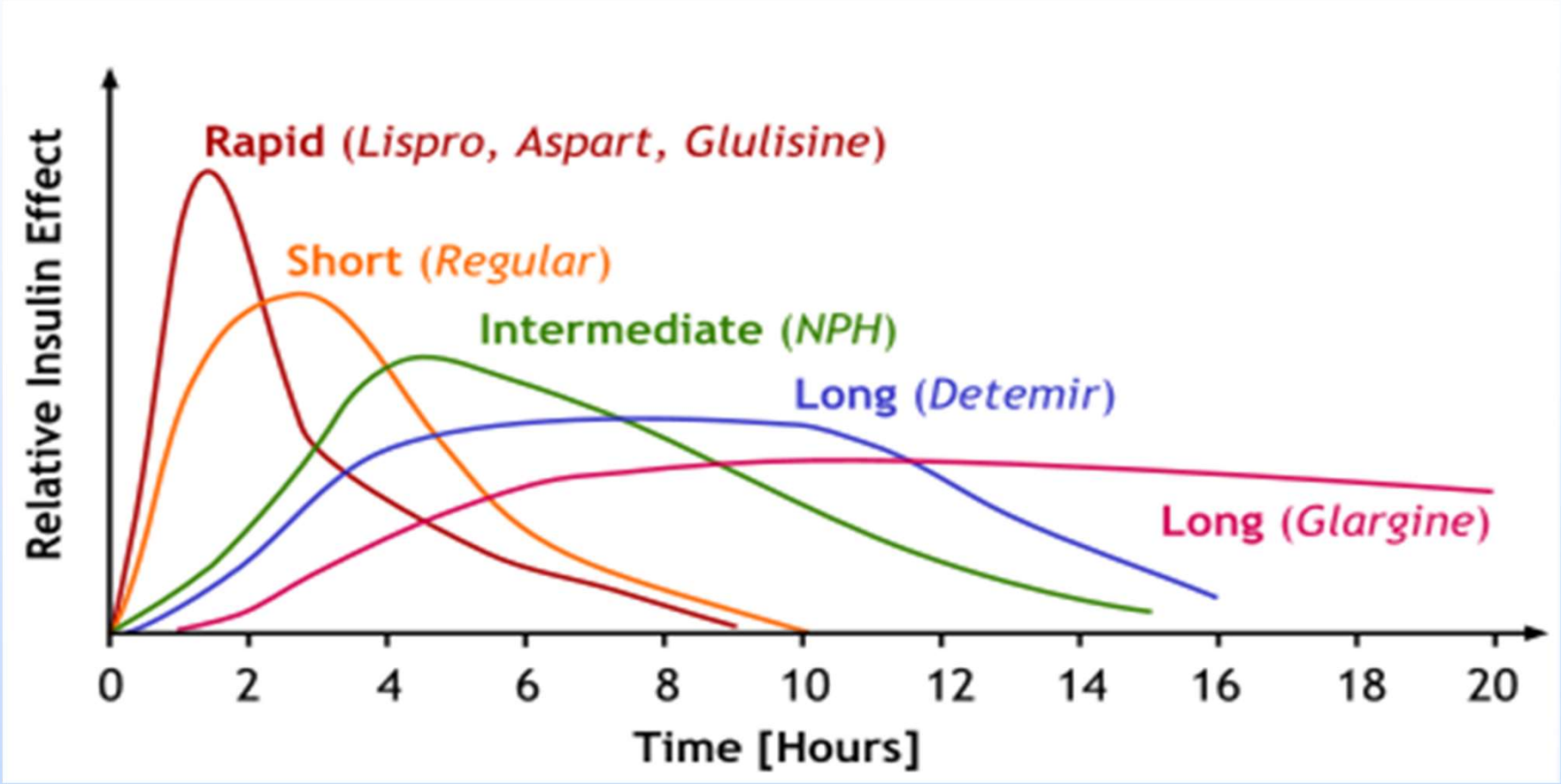
American Horror Story: Hospital Edit



Small Group Cases (10 min)

- In groups of 2-3 people, work through the cases at your tables
- We will discuss answers as a large group

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1. **A 75-year-old male with a past medical history of diabetes mellitus and chronic kidney disease (CKD) presents overnight with altered mental status and acute kidney injury. Upon arrival, his blood sugar is 200. His home insulin dose of 15 units "70/30" Novolin BID is ordered with a "now" dose. The patient receives 15 units upon arrival at 0500. Two hours later, his AM dose is due, and he receives another 15 units plus sliding scale insulin per protocol for a blood sugar of 179. Two hours later a rapid response is called as patient is found unresponsive and with a blood sugar of 35.**

a. What contributed to this patient's hypoglycemic event?

b. Why are pre-mixed insulins not commonly used in the hospital?

c. The patient's admission weight is 75 kg. Calculate the appropriate admission insulin regimen keeping in mind the patient's co-morbidities.

d. The patient is NPO given his altered mental status. What should you do now with his insulin regimen?

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2. A 19-year-old female presents with DKA. She is appropriately placed on IV insulin infusion with intravenous fluids. Twelve hours later, her anion gap has closed, and her blood sugars are ranging between 150 and 200 mg/dl. She is ready for conversion to subcutaneous insulin.

a. The average hourly rate over the last 8 hours is 2 units/hour, and the patient has been eating. Calculate the 24-hour insulin requirement. Calculate the appropriate basal-bolus insulin dosing.

b. How soon after giving long-acting insulin should the insulin gtt be turned off?

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3. A 65-year-old morbidly obese female with type II diabetes mellitus presents with acute COPD exacerbation. She takes U-500 insulin as an outpatient but is not always compliant. Her last A1C was 10.5%. Her blood glucose on admission is 325 mg/dl. She received 125 mg IV solumedrol in the Emergency Department. Her labs are within normal limits except for her blood glucose.

a. Should her U-500 insulin be held on admission?
b. Calculate her basal-bolus insulin dosing regimen based on an admission weight of 112 kg keeping in mind her medical co-morbidities.
c. Two days into the patient's hospital admission, her blood glucose levels have been consistently > 200 mg/dL. Re-calculate her insulin dosing.

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4. A 47-year-old male presents with right lower extremity cellulitis and is admitted to the hospital. He was diagnosed with type 2 diabetes mellitus 5 years ago and his A1C has been increasing over the last year. He is on 20 units of Lantus QHS and Jardiance. His last A1C was 9.5%. He hands you his glucometer and all his blood glucose levels have been between 100 and 150 mg/dl. He checks his blood sugars fasting and before meals. BMI = 22.

a. What is the best inpatient regimen for this patient? Calculate his insulin dosing (weight = 80 kg).
b. What are possible explanations for the discrepancy between his A1C and blood glucose levels?

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Take Home Points

- ✓Use standardized dose estimates to calculate total daily insulin dose based on patient's weight, medical co-morbidities, and nutritional status
- ✓Recall conditions that alter insulin metabolism (elderly, underweight, liver disease, renal disease = hypoglycemia) (obesity, steroids = hyperglycemia)
- ✓Hold SGLT2 inhibitors
- ✓Episodes of hypoglycemia are worse in the short term in hospitalized patients

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THANK YOU!

Questions? Further Discussion?