Overview of Diabetes Management in the Hospital

Diabetes management in the hospital setting is critical to prevent complications such as hyperglycemia, hypoglycemia, diabetic ketoacidosis (DKA), and hyperosmolar hyperglycemic state (HHS). Inpatient hyperglycemia is associated with increased morbidity, mortality, and length of stay, particularly in critically ill patients. This guide provides students with a comprehensive framework for managing diabetes in hospitalized patients, including glucose goals, home medication adjustments, insulin titration, and safe continuation of diabetes medications, with tables and clinical scenarios for practical application.

Clinical Presentation of Dysglycemia in the Hospital

Hyperglycemia:

• **Symptoms:** Polyuria, polydipsia, fatigue, blurred vision, delayed wound healing.

• **Signs:** Glucose >180 mg/dL, dehydration, tachycardia (if DKA/HHS).

• **Risk Factors:** Stress (e.g., infection, surgery), steroids, TPN, enteral feeding, missed insulin doses.

Hypoglycemia:

• **Symptoms:** Sweating, shakiness, confusion, irritability, seizures (severe).

• **Signs:** Glucose <70 mg/dL, sympathetic activation (tachycardia, diaphoresis), neuroglycopenic symptoms (confusion, coma).

• **Risk Factors:** Overdose of insulin/sulfonylureas, reduced oral intake, renal/hepatic impairment.

DKA/HHS:

• **DKA:** Nausea, vomiting, abdominal pain, Kussmaul respirations, fruity breath; glucose 250-600 mg/dL, pH <7.3, ketones positive.

• **HHS:** Severe hyperglycemia (>600 mg/dL), altered mental status, dehydration; pH >7.3, minimal/no ketones.

Glucose Goals in the Hospital

General Inpatient Goals:

• **Non-Critically Ill:** 140-180 mg/dL (pre-meal <140 mg/dL, random <180 mg/dL).

• **Critically Ill (ICU):** 140-180 mg/dL; avoid tight control (80-110 mg/dL) due to hypoglycemia risk.

• **Perioperative:** 110-180 mg/dL (stricter control to reduce infection risk).

• **Hypoglycemia Threshold:** <70 mg/dL (treat if symptomatic or <54 mg/dL regardless of symptoms).

Rationale:

• Hyperglycemia (>180 mg/dL) increases infection risk, delays healing, and worsens outcomes.

• Hypoglycemia (<70 mg/dL) can cause seizures, coma, and increased mortality in ICU patients.

• **Individualize goals:** Avoid tight control in patients with severe comorbidities, history of severe hypoglycemia, or limited life expectancy.

Home Diabetes Medications: Which to Hold and Which to Continue

Medications to Hold:

• **Metformin:** Hold due to risk of lactic acidosis (e.g., AKI, contrast dye, hypoxia).

• **Sulfonylureas (e.g., Glimepiride, Glipizide):** Hold due to high risk of hypoglycemia (long half-life, reduced oral intake).

• **Meglitinides (e.g., Repaglinide):** Hold due to hypoglycemia risk with inconsistent meals.

• **GLP-1 Agonists (e.g., Liraglutide, Semaglutide):** Hold if nausea/vomiting (e.g., GI illness, surgery); can continue if patient is stable, eating, and no GI symptoms.

• **DPP-4 Inhibitors (e.g., Sitagliptin):** Hold in severe illness (e.g., AKI, liver failure); can continue if stable and eating.

Medications to Continue (If Safe):

• **Insulin:** Continue but adjust doses; avoid stopping basal insulin to prevent DKA.

• **SGLT2 Inhibitors (e.g., Empagliflozin, Canagliflozin):** Can often be continued or started in the hospital if patient is stable (e.g., euvolemic, normal renal function, eating well), as euglycemic DKA is rare. However, monitor closely for extreme polyuria, dehydration, and hypotension due to hypovolemia, especially in acutely ill patients or those with reduced oral intake. Hold if signs of hypovolemia (e.g., BP drop, tachycardia) or polyuria develop.

• **GLP-1 Agonists:** Can continue in stable patients without GI symptoms.

• **DPP-4 Inhibitors:** Can continue in stable patients with normal renal function.

• **Thiazolidinediones (e.g., Pioglitazone):** Can continue if no heart failure or fluid overload.

Rationale:

• Many oral medications increase the risk of adverse events (e.g., hypoglycemia, lactic acidosis) in the hospital due to changes in renal function, oral intake, or acute illness.

• SGLT2 inhibitors, while often safe to continue, require careful monitoring for hypovolemia-related complications.

• Insulin is the safest and most effective option for inpatient glycemic control.

Insulin Management in the Hospital

Sliding Scale Insulin (SSI):

- Purpose: Correct hyperglycemia (often used with basal insulin).
- Titration:
    - Low-Dose (Sensitive Patients, e.g., T1DM, Low BMI):
        - **Glucose 181-250 mg/dL:** 2 units rapid-acting insulin (e.g., lispro, aspart) SC.
        - **Glucose 251-300 mg/dL:** 4 units.
        - **Glucose 301-350 mg/dL:** 6 units.
        - **Glucose >350 mg/dL:** 8 units, call MD.
    - Moderate-Dose (Average Patients):
        - **Glucose 181-250 mg/dL:** 4 units.
        - **Glucose 251-300 mg/dL:** 6 units.
        - **Glucose 301-350 mg/dL:** 8 units.

- **Glucose >350 mg/dL:** 10 units, call MD.
    - High-Dose (Insulin-Resistant, e.g., T2DM, Obesity, Steroids):
        - **Glucose 181-250 mg/dL:** 6 units.
        - **Glucose 251-300 mg/dL:** 8 units.
        - **Glucose 301-350 mg/dL:** 10 units.
        - **Glucose >350 mg/dL:** 12 units, call MD.
- Frequency for Non-ICU Patients:
- • Check glucose ACHS (before meals and at bedtime); administer SSI with meals and at bedtime if needed. Adjust SSI based on trends (e.g., increase by 1-2 units per dose if glucose remains >180 mg/dL across multiple checks).
- Frequency for ICU Patients:
- • Check glucose q1-2h; adjust SSI or IV insulin based on protocol.

When to Start Long-Acting Insulin:

- Indication: Persistent hyperglycemia (>180 mg/dL) despite SSI, or known diabetes requiring basal insulin at home.
- Timing: Start within 24-48 hours of admission if SSI alone is insufficient (e.g., >2 consecutive ACHS glucose readings >180 mg/dL).
- Dosing:
    - **Initial Dose:** 0.2-0.3 units/kg/day of glargine or detemir SC (e.g., 70 kg patient: 14-21 units), typically given at bedtime.
    - Titration: Increase by 10-20% daily if fasting glucose (pre-breakfast ACHS) >180 mg/dL; decrease by 10-20% if hypoglycemia (<70 mg/dL) occurs.
- Rationale: Basal insulin prevents DKA in T1DM and reduces reliance on SSI in T2DM, improving glycemic control.

Insulin in Critical Illness:

- IV Insulin Drip: Use in DKA, HHS, or ICU patients with glucose >180 mg/dL despite SC insulin.
    - Start at 0.05-0.1 units/kg/h (e.g., 70 kg patient: 3.5-7 units/h).
    - Titrate:
    - Check glucose q1h, adjust to maintain 140-180 mg/dL (increase by 1-2 units/h if >180 mg/dL, decrease by 0.5-1 unit/h if <100 mg/dL).
    - Transition to SC insulin when stable (overlap IV and SC by 2-4 hours to prevent rebound hyperglycemia).

Safe Continuation of Diabetes Medications

Table: Management of Home Diabetes Medications in the Hospital

Medication Class	Action in Hospital	Rationale
Metformin	Hold	Risk of lactic acidosis (AKI, hypoxia, contrast dye)
SGLT2 Inhibitors	Continue if stable (euvolemic, normal renal function, eating); monitor for extreme polyuria, dehydration, hypotension due to hypovolemia; hold if hypovolemia or polyuria develops	Euglycemic DKA rare, but risk of hypovolemia and hypotension; can be beneficial for glycemic control if monitored
Sulfonylureas	Hold	High risk of hypoglycemia (long half-life, reduced intake)
Meglitinides	Hold	Hypoglycemia risk with inconsistent meals
GLP-1 Agonists	Hold if GI symptoms; continue if stable	Nausea/vomiting risk in acute illness; safe if eating
DPP-4 Inhibitors	Hold if severe illness; continue if stable	Risk in AKI, liver failure; safe if renal function normal
Thiazolidinediones	Continue if no CHF/fluid overload	Risk of fluid retention in CHF
Insulin	Continue, adjust doses	Safest option; avoid stopping basal to prevent DKA

Hospital Management of Diabetes Complications

Hyperglycemia:

- **Monitor:** For non-ICU patients, check glucose ACHS (before meals and at bedtime); for ICU patients, check q1-2h.
- **Treat:** Administer SSI with meals and at bedtime if needed, start basal insulin if persistent (>180 mg/dL), IV insulin drip in DKA/HHS.
- **Address Cause:** Treat infection (e.g., antibiotics), adjust steroids, ensure adequate nutrition.

Hypoglycemia:

- Treat:
  - **If conscious:** 15-20 g fast-acting carbs (e.g., 4 oz juice, glucose gel), recheck glucose in 15 minutes.

- ◦ **If unconscious:** D50W 50 mL IV push, or glucagon 1 mg IM if no IV access.
- Prevent: Reduce insulin doses (10-20% if <70 mg/dL), ensure meal timing, monitor ACHS for non-ICU patients.

DKA:

- Diagnosis: Glucose >250 mg/dL, pH <7.3, ketones positive, anion gap >12.
- Management; **IV fluids:** NS 1-2 L bolus, then 250-500 mL/h.
- **IV insulin:** 0.1 units/kg/h, continue until gap closes (target glucose 150-200 mg/dL during treatment).
- **Electrolytes:** K+ (replace if <5.2 mEq/L), monitor for hypokalemia.
- **Treat precipitant:** Antibiotics for infection, stop offending meds.

HHS:

- Diagnosis: Glucose >600 mg/dL, osmolarity >320 mOsm/kg, pH >7.3, minimal ketones.
- Management:
    - ◦ **IV fluids:** NS 1-2 L bolus, then 250-500 mL/h (correct osmolarity slowly to avoid cerebral edema).
    - ◦ **IV insulin:** 0.05-0.1 units/kg/h after fluid resuscitation (target glucose 200-300 mg/dL initially).
    - ◦ **Electrolytes:** K+, Na+ correction, monitor for hypokalemia.
    - ◦ **Treat precipitant:** Similar to DKA.

SGLT2 Inhibitor Complications:

- Extreme Polyuria and Hypovolemia:
- Monitor for excessive urination, dehydration (e.g., dry mucous membranes, tachycardia), and hypotension (e.g., BP drop). If present, hold SGLT2i, administer IV fluids (e.g., NS 1 L bolus), and reassess volume status.
- Rationale: SGLT2i increase glucosuria, leading to osmotic diuresis, which can cause hypovolemia, especially in patients with reduced oral intake or acute illness.

Key Pearls

- **Glucose Goals:** 140-180 mg/dL (non-ICU/ICU), tighter (110-180 mg/dL) perioperatively.

- **Glucose Checks (Non-ICU):** ACHS (before meals and bedtime) to guide SSI and basal insulin adjustments.

- **Hold Medications:** Metformin, sulfonylureas (risk of lactic acidosis, hypoglycemia).

- **SGLT2 Inhibitors:** Can continue if stable, but monitor for polyuria, dehydration, hypotension; hold if hypovolemia develops.

- **Sliding Scale Insulin:** Titrate based on ACHS glucose (e.g., 2-12 units rapid-acting), adjust per patient sensitivity.

- **Long-Acting Insulin:** Start at 0.2-0.3 units/kg/day if persistent hyperglycemia, titrate 10-20% daily based on fasting ACHS glucose.

- **Complications:** Hyperglycemia (SSI, basal insulin), hypoglycemia (D50W, adjust doses), DKA/HHS (IV fluids, insulin drip), SGLT2i-related hypovolemia (hold, fluids).

References

- **UpToDate:** "Inpatient Management of Hyperglycemia" (2025). UpToDate Diabetes

- **ADA:** "Standards of Medical Care in Diabetes" (2024). ADA Guidelines

- **AACE:** "Inpatient Glycemic Control Guidelines" (2023). AACE Guidelines

- **NEJM:** "Management of DKA and HHS in the Hospital" (2024). NEJM DKA

Case Scenarios

Case 1: A 65-Year-Old Male with Pneumonia and Hyperglycemia

- Presentation: A 65-year-old male with T2DM (on metformin, empagliflozin) is admitted for pneumonia. ACHS glucose readings are 220-280 mg/dL, Cr 1.5 mg/dL (baseline 1.0). Exam shows T 38°C, BP 110/70 mmHg, RR 20/min, SpO2 94% on 2L O2.
- Labs/Studies: Glucose 250 mg/dL (pre-dinner ACHS), HbA1c 8.5%, normal pH, no ketones.
- Diagnosis: Hyperglycemia (T2DM, Stress-Induced) → Elevated ACHS glucose, acute illness, no DKA.
- Management: Hold metformin (AKI risk). Continue empagliflozin but monitor for polyuria/hypovolemia (no issues noted). Start SSI (moderate-dose: 4-10 units lispro SC with meals and bedtime). ACHS glucose remains >180 mg/dL after 24h; start glargine 20 units SC at bedtime (0.3 units/kg). Titrate glargine (increase to 24 units on day 3 as fasting glucose 200 mg/dL). Antibiotics for pneumonia (ceftriaxone + azithromycin). Glucose stabilizes at 150-170 mg/dL. Discharge with metformin held, empagliflozin continued, and glargine 24 units daily.

Case 2: A 30-Year-Old Female with DKA

- Presentation: A 30-year-old female with T1DM presents with nausea, vomiting, and abdominal pain. Exam shows T 37.5°C, BP 100/60 mmHg, RR 28/min, Kussmaul respirations, fruity breath.
- Labs/Studies: Glucose 400 mg/dL, pH 7.1, bicarbonate 10 mEq/L, anion gap 20, beta-hydroxybutyrate positive.
- Diagnosis: DKA (T1DM, Non-Adherence) → Hyperglycemia, acidosis, ketones.
- Management: Admit to ICU. IV fluids (NS 2 L bolus, then 250 mL/h). Start IV insulin 0.1 units/kg/h (7 units/h for 70 kg). K+ 4.0 mEq/L (replace with 20 mEq KCl IV). Glucose decreases to 180 mg/dL, gap closes (bicarbonate 18 mEq/L). Transition to glargine 20 units SC at bedtime + SSI (overlap IV insulin by 2h). Check ACHS glucose on transition (stable at 140-180 mg/dL). Educate on insulin adherence. Discharge with endocrinology follow-up.

Case 3: A 70-Year-Old Male with Hypoglycemia and SGLT2i-Related Hypovolemia

- Presentation: A 70-year-old male with T2DM (on empagliflozin, insulin glargine 30 units) is admitted for cellulitis. On day 2, he becomes sweaty, confused, and reports frequent urination (10-12 times/day). Exam shows T 37°C, BP 90/60 mmHg (baseline 130/80), HR 100 bpm, glucose 50 mg/dL, dry mucous membranes.
- Labs/Studies: Glucose 50 mg/dL, Cr 1.2 mg/dL, normal LFTs, urine output 3 L/day.
- Diagnosis: Hypoglycemia (Reduced Intake) and SGLT2i-Related Hypovolemia → Low glucose, hypotension, polyuria, empagliflozin use.
- Management: Hold empagliflozin (hypovolemia, polyuria). Give D50W 50 mL IV for hypoglycemia (glucose rises to 120 mg/dL). IV fluids (NS 1 L bolus, then 150 mL/h) for hypovolemia (BP improves to 120/75 mmHg). Reduce glargine to 24 units (20% decrease). Monitor ACHS glucose (remains 100-160 mg/dL). Antibiotics for cellulitis (cefazolin 1 g IV q8h). Discharge with empagliflozin held, glargine 24 units, and outpatient follow-up to reassess SGLT2i.

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