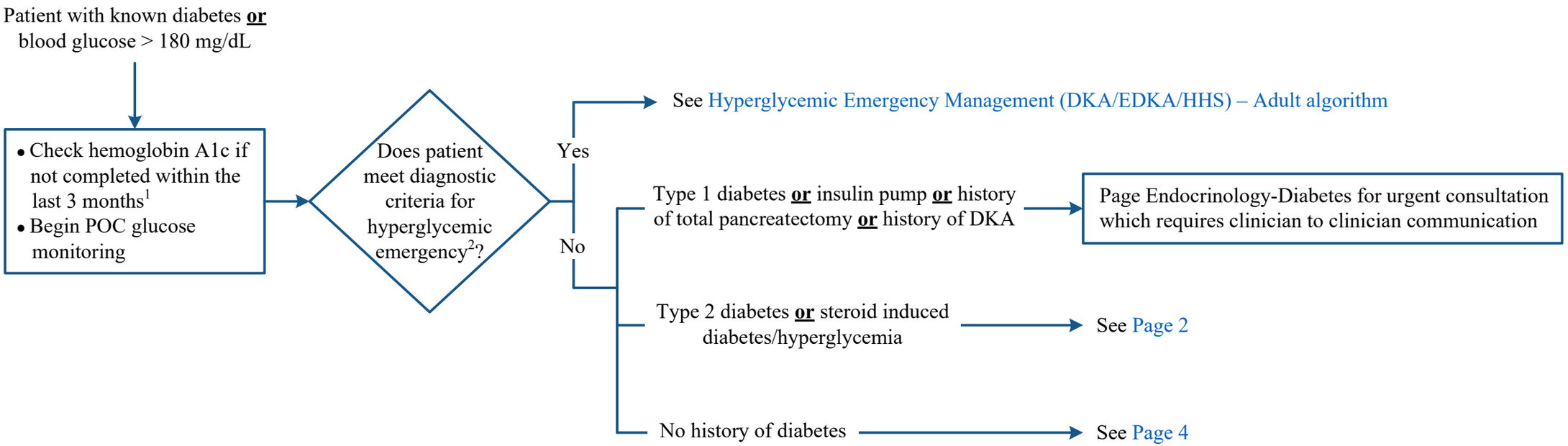
Inpatient Hyperglycemia - Adult

Note: Insulin dose adjustments should be made based on the individual patient's glucoses. Refer to the Hypoglycemia Management algorithm, as indicated.

PRESENTATION | **INITIAL EVALUATION** | **TREATMENT**



DKA = diabetic ketoacidosis
EDKA = euglycemic diabetic ketoacidosis
HHS = hyperosmolar hyperglycemic state
POC = point of care

[1] Hemoglobin A1c may be inaccurate if recent blood transfusion within the past three months or severe anemia
[2] Diagnostic criteria:
DKA: blood glucose > 250 mg/dL, arterial or venous pH < 7.3, bicarbonate < 15 mEq/L, beta hydroxybutyrate (BHB) > 3 mmol/L, osmolality < 320 mosm/kg
EDKA: blood glucose ≤ 250 mg/dL, arterial or venous pH < 7.3, bicarbonate < 15 mEq/L, BHB > 3 mmol/L, osmolality < 320 mosm/kg
[**Note:** Blood glucose may be lower than expected in patients on SGLT-2 inhibitors (*e.g.*, canagliflozin, dapagliflozin, empagliflozin, ertugliflozin)]
DKA with HHS: blood glucose > 600 mg/dL, arterial or venous pH < 7.3, bicarbonate < 15 mEq/L, BHB > 3 mmol/L, osmolality ≥ 320 mosm/kg
HHS: blood glucose > 600 mg/dL, arterial or venous pH ≥ 7.3, bicarbonate ≥ 15 mEq/L, BHB ≤ 3 mmol/L, osmolality ≥ 320 mosm/kg

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Inpatient Hyperglycemia - Adult

Note: Insulin dose adjustments should be made based on the individual patient's glucoses. Refer to the Hypoglycemia Management algorithm, as indicated.

PRESENTATION

Type 2 diabetes or steroid induced diabetes/hyperglycemia

- Stop high-risk home medications[1]
- Hold metformin if eGFR < 45 mL/minute/1.73 m^2

ASSESSMENT

Is patient on > 100 units of insulin daily[2] **or** on Humulin U-500 insulin at home?

- Yes → Consult Endocrinology-Diabetes
- No → Does patient have risk factors for hyperglycemia or hypoglycemia[3]?
  - Yes → See Page 3
  - No → Initiate basal bolus insulin therapy at 0.4 units/kg/day subcutaneous with 50% of TDD used for prandial fixed bolus (lispro) dosing and 50% used for basal (glargine) dosing (see Appendix A and B)[4]
    - Assess insulin needs every 24 hours
    - Consider a no concentrated carbohydrate diet

Are any glucose levels > 180 mg/dL after 48 hours?

TREATMENT

- Yes → Consult General Internal Medicine (Consultative Medicine - Inpatient Consults) or Endocrinology-Diabetes
- No → Discharge planning:
  - Consider resuming home medications, as appropriate
  - Consider the following as clinically indicated:
    - For patients with hemoglobin A1c < 7.5%:
      - Follow up with treating physician, primary care physician, or endocrinologist
    - For patients with hemoglobin A1c 7.5-9%:
      - Consult Certified Diabetes Care and Education Specialist (Diabetes Educator)
      - Follow up with treating physician, primary care physician, or endocrinologist **or** arrange ambulatory referral to Consultative Medicine (General Internal Medicine)
    - For patients with hemoglobin A1c > 9% **or** new to insulin on discharge:
      - Consult Certified Diabetes Care and Education Specialist (Diabetes Educator)
      - Arrange ambulatory referral to Endocrinology-Diabetes

eGFR = estimated glomerular filtration rate
NPH = neutral protamine Hagedorn
NPO = nothing by mouth
TDD = total daily dose
PN = parenteral nutrition

Note: Refer to Insulin Decision Support Tool to assist in placing orders (for internal use only)

[1] Hold home insulin and oral hypoglycemic agents such as sulfonylureas (*e.g.*, glipizide, glyburide, glimepiride, gliclazide), meglitinides (*e.g.*, repaglinide, nateglinide) and SGLT-2 inhibitors (*e.g.*, canagliflozin, dapagliflozin, empagliflozin, ertugliflozin). Generally, metformin and DPP-4 inhibitors (*e.g.*, sitagliptin, linagliptin, saxagliptin) are safe to continue if renal and liver function are stable.

[2] Calculation of total daily insulin taken at home: add the total units of all long acting (glargine, degludec, or detemir), intermediate acting (NPH), and short acting (lispro, aspart, glulisine, or regular) insulin in a typical 24 hour period

[3] Risk factors for hyperglycemia include: • New enteral feedings or PN • Post-operative status • High dose steroids (see Page 3)
Risk factors for hypoglycemia include: • Acute or chronic renal failure • Poor nutritional status or oral intake • Failure to thrive • NPO status for anticipated procedures

[4] For critically ill patients, refer to IP Critical Care Glycemic Management order set; consider insulin infusion for 2 consecutive glucose levels > 200 mg/dL within 24 hours. Refer to Appendix C for transition from insulin infusion to basal bolus insulin therapy.

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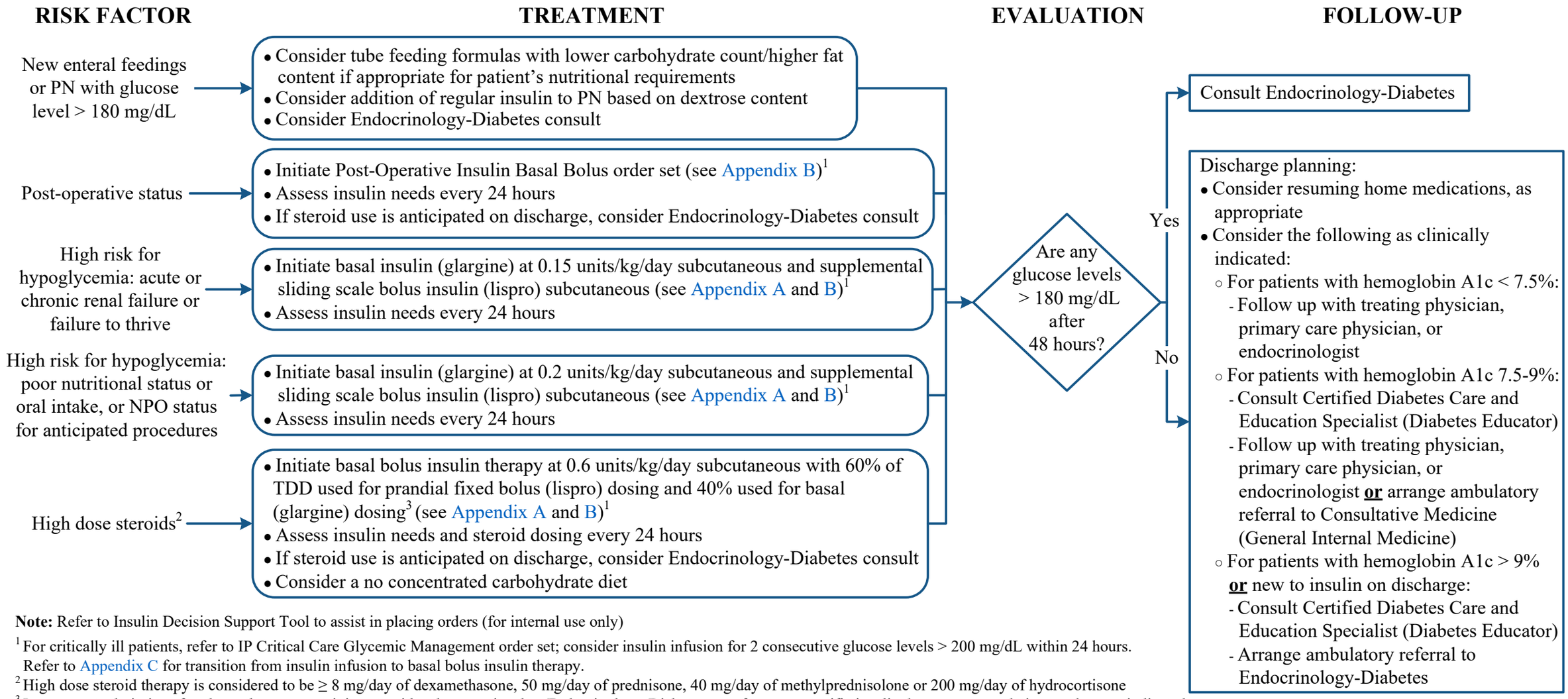
Inpatient Hyperglycemia - Adult

Note: Insulin dose adjustments should be made based on the individual patient's glucoses. Refer to the Hypoglycemia Management algorithm, as indicated.

TYPE 2 DIABETES OR STEROID INDUCED DIABETES/HYPERGLYCEMIA



Note: Refer to Insulin Decision Support Tool to assist in placing orders (for internal use only)

[1] For critically ill patients, refer to IP Critical Care Glycemic Management order set; consider insulin infusion for 2 consecutive glucose levels > 200 mg/dL within 24 hours. Refer to Appendix C for transition from insulin infusion to basal bolus insulin therapy.

[2] High dose steroid therapy is considered to be ≥ 8 mg/day of dexamethasone, 50 mg/day of prednisone, 40 mg/day of methylprednisolone or 200 mg/day of hydrocortisone

[3] In recurrent admissions for chemotherapy containing steroids, please review last Endocrinology-Diabetes note for more specific insulin dose recommendations and use as indicated

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Inpatient Hyperglycemia - Adult

Note: Insulin dose adjustments should be made based on the individual patient's glucoses. Refer to the Hypoglycemia Management algorithm, as indicated.

PRESENTATION

No history of diabetes

Is patient on high dose steroid therapy[1]?

Yes

- Initiate basal bolus insulin therapy at 0.5 units/kg/day subcutaneous with 60% of TDD used for prandial fixed bolus (lispro) dosing and 40% used for basal (glargine) dosing (see Appendix A and B)
- Assess insulin needs and steroid dosing every 24 hours
- Consider a no concentrated carbohydrate diet

No

- Initiate Adult Insulin Sliding Scale order set or Critical Care Glycemic Management order set[2] as indicated
- If patient has received checkpoint inhibitors[3] within the past year, consult Endocrinology-Diabetes
- Assess insulin needs every 24 hours

ASSESSMENT

Are any glucose levels > 180 mg/dL after 48 hours?

Yes

- Consult Certified Diabetes Care and Education Specialist (Diabetes Educator)
- Consult Endocrinology-Diabetes

No

- Consider initiation of basal bolus insulin therapy at 0.3 units/kg/day subcutaneous with 50% of TDD used for prandial fixed bolus (lispro) dosing and 50% used for basal (glargine) dosing (see Appendix A and B)
- Assess insulin needs every 24 hours

Are there 2 consecutive glucose levels > 180 mg/dL within 24 hours?

Yes

No

Is patient going home on steroid therapy?

Yes

No

TREATMENT

Discharge planning:

- Consider the following as clinically indicated:
  - For patients with hemoglobin A1c 6.5-7.5%:
    - For patients with new diagnosis of diabetes, consult Certified Diabetes Care and Education Specialist (Diabetes Educator)
    - Follow up with treating physician, primary care physician, or endocrinologist
  - For patients with hemoglobin A1c 7.5-9%:
    - Consult Certified Diabetes Care and Education Specialist (Diabetes Educator)
    - Follow up with treating physician, primary care physician, or endocrinologist **or** arrange ambulatory referral to Consultative Medicine (General Internal Medicine)
  - For patients with hemoglobin A1c > 9% **or** new to insulin on discharge:
    - Consult Certified Diabetes Care and Education Specialist (Diabetes Educator)
    - Arrange ambulatory referral to Endocrinology-Diabetes

Note: Refer to Insulin Decision Support Tool to assist in placing orders (for internal use only)

[1] High dose steroid therapy is considered to be ≥ 8 mg of dexamethasone, 50 mg of prednisone, 40 mg of methylprednisolone or 200 mg of hydrocortisone per day

[2] For critically ill patients, consider insulin infusion for 2 consecutive glucose levels > 200 mg/dL within 24 hours. Refer to Appendix C for transition from insulin infusion to basal bolus insulin therapy.

[3] Checkpoint inhibitors: nivolumab, pembrolizumab, durvalumab, atezolizumab, and related drugs. Patients with recent exposure to checkpoint inhibitors are at risk for DKA and should be evaluated for new onset type 1 diabetes mellitus.

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Inpatient Hyperglycemia - Adult

APPENDIX A: Common Insulin Types and Frequency

Fast Acting Insulin	Dose Frequency
Lispro (Humalog® or Lyumjev®[1])	Before meals or every 4 hours
Aspart (Novolog® or Fiasp®)[1]	Before meals or every 4 hours
Glulisine (Apidra®)[1]	Before meals or every 4 hours
Regular insulin (Novolin®-R/Humulin®-R)	Before meals or every 6 hours
Long Acting Insulin	
Glargine (Lantus®/Basaglar®/Toujeo®/ Semglee®[1])	Daily or every 12 hours
Detemir (Levemir®)	Daily or every 12 hours
Degludec (Tresiba®)[1]	Daily
Intermediate Acting Insulin	
NPH (Novolin®-N/Humulin®-N)	Every 12 hours
Mixed Insulin	
70/30, 75/25[1], 50/50[1] (mixes of NPH and a fast acting insulin)	Every 12 hours or every 6 hours with continuous tube feedings

[1] Not currently on MD Anderson Formulary

APPENDIX B: Basal Bolus Insulin Terms

- **Bolus** insulin refers to a dose of fast acting insulin. This is typically comprised of **prandial** insulin which is scheduled to compensate for the carbohydrate content of a meal and **supplemental** (or sliding scale) insulin to correct hyperglycemia. Bolus insulin is most effective when given before meals, but supplemental insulin alone can be scheduled for patients who are not eating or are high risk for hypoglycemia.
- **Basal** insulin refers to a dose of long acting insulin given 1 or 2 times daily. These insulins absorb slowly to help maintain stable glucose levels.
- **Supplemental** insulin is dosed based on either weight or total daily insulin requirement
- A **basal/bolus** insulin regimen uses both types of insulin to recreate a physiologic pattern of insulin release. This regimen is more effective for most patients than sliding scale supplemental insulin only. Most patients need about half of their insulin as basal and half as bolus. Patients on high doses of steroids will often need more bolus insulin.

Inpatient Hyperglycemia - Adult

APPENDIX C: Critical Care Insulin Infusion Transition

Note: This does NOT apply to patients with DKA, EDKA, or HHS
(see Hyperglycemic Emergency Management (DKA/EDKA/HHS) – Adult algorithm)

Clinical judgement may supersede exact calculation of total daily dose if patient's clinical status has rapidly changed during transition period.

Patient on ICU insulin infusion **and** meets **ALL** of the following criteria:
- Not in DKA/EDKA/HHS
- Maintained on insulin infusion ≥ 6 hours
- Controlled blood glucose (≥ 3 blood glucoses < 180 mg/dL in past 6 hours)
- Steady insulin infusion doses for a minimum of 6 hours (not varying by > 2 units/hour)

→ Does patient meet any exclusion criteria[1]?

Yes →
- Continue insulin infusion and re-evaluate as clinically indicated
- Consider Endocrinology-Diabetes Consult for transitioning off of insulin infusion

No →
Calculate estimated TDD of subcutaneous insulin by multiplying the average hourly insulin infusion dose from the previous 6 hours by 24 and then multiply by 0.8[2,3]

Calculate estimated TDD of subcutaneous insulin by multiplying the average hourly insulin infusion dose from the previous 6 hours by 24 and then multiply by 0.8[2,3] →

NPO or eating < 50% of meals →
- Initiate basal insulin (glargine) subcutaneously with dose based on 50% TDD
- POC glucose checks every 6 hours
- Discontinue insulin infusion 2 hours after basal insulin administered
- Initiate supplemental sliding scale bolus insulin (regular) subcutaneous every 6 hours
  - TDD < 40 units: Low dose
  - TDD 40 - 80 units: Medium dose
  - TDD > 80 units: High dose
- See Appendix D for basal/bolus insulin calculation tables
- Reassess when patient is tolerating oral diet or enteral feedings as indicated

Eating ≥ 50% of meals or on intermittent enteral feedings →
- Initiate basal insulin (glargine) subcutaneously with dose based on 50% of TDD
- POC glucose checks three times daily before meals and at bedtime
- Discontinue insulin infusion 2 hours after basal insulin administered
- Initiate prandial sliding scale bolus insulin (lispro) subcutaneous using 50% of TDD divided into three pre meal doses
- Initiate supplemental pre meal sliding scale bolus insulin (lispro) subcutaneous
  - TDD < 40 units: Low dose
  - TDD 40 - 80 units: Medium dose
  - TDD > 80 units: High dose
- See Appendix D for basal/bolus insulin calculation tables

Continuous enteral feedings →
- Initiate basal insulin (glargine) subcutaneously with dose based on 50% of TDD
- POC glucose checks every 6 hours
- Discontinue insulin infusion 2 hours after basal insulin administered
- Initiate scheduled bolus insulin (regular) subcutaneous using 50% of TDD divided into every 6 hour doses
- Initiate supplemental sliding scale bolus insulin (regular) subcutaneous every 6 hours
  - TDD < 40 units: Low dose
  - TDD 40 - 80 units: Medium dose
  - TDD > 80 units: High dose
- See Appendix D for basal/bolus insulin calculation tables

[1] Exclusion criteria include: Currently receiving vasopressor therapy or parenteral nutrition (PN) **or** steroid dose fluctuating > 20% in the past 24 hours **or** insulin infusion dose > 5 units/hour **or** enteral feedings not at goal rate

[2] Example: Average hourly infusion dose from the previous 6 hours = 3 units/hour; multiple by 24 = 72 units; multiply by 0.8 = 57.6 units, rounded up to 58 units = TDD; see Appendix D for basal/bolus insulin calculation tables

[3] Consider decreasing the TDD by 20% for patients with renal dysfunction; Example: TDD = 58 units decreased by 20% = 46 units

Note: After transitioning off of insulin infusion, continue to evaluate glycemic control and adjust management as clinically indicated

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APPENDIX D: Basal/Bolus Insulin Dosing Calculation Tables

Note: • Clinical judgement may supersede exact calculation of total daily dose if patient's clinical status has rapidly changed during transition period
• Consider dose reduction in patients with renal dysfunction

NPO or Eating < 50% of Meals

Average Hourly Dose of Insulin Infusion	First Dose of Basal Insulin (Glargine)	Maintenance Dose of Basal Insulin (Glargine)[1]	Dose of Prandial (Pre-Meal) Scheduled Short/Rapid Acting	Regular Insulin Supplemental Sliding Scale
Less than or equal to 1 unit/hour	9 units once	5 units every 12 hours	-	Low dose sliding scale every 6 hours
2 units/hour	19 units once	10 units every 12 hours	-	Low dose sliding scale every 6 hours
3 units/hour	28 units once	14 units every 12 hours	-	Medium dose sliding scale every 6 hours
4 units/hour	38 units once	19 units every 12 hours	-	Medium dose sliding scale every 6 hours
5 units/hour	48 units once	24 units every 12 hours	-	High dose sliding scale every 6 hours

Eating ≥ 50% of Meals or Intermittent Enteral Feedings

Average Hourly Dose of Insulin Infusion	First Dose of Basal Insulin (Glargine)	Maintenance Dose of Basal Insulin (Glargine)[1]	Dose of Prandial (Pre-Meal)[2] Scheduled Lispro	Lispro Insulin Supplemental Sliding Scale
Less than or equal to 1 unit/hour	9 units once	5 units every 12 hours	3 units three times daily before meals	Low dose sliding scale three times daily before meals
2 units/hour	19 units once	10 units every 12 hours	6 units three times daily before meals	Low dose sliding scale three times daily before meals
3 units/hour	28 units once	14 units every 12 hours	9 units three times daily before meals	Medium dose sliding scale three times daily before meals
4 units/hour	38 units once	19 units every 12 hours	12 units three times daily before meals	Medium dose sliding scale three times daily before meals
5 units/hour	48 units once	24 units every 12 hours	16 units three times daily before meals	High dose sliding scale three times daily before meals

[1] Maintenance dose of basal insulin (glargine) should start no sooner than 12 hours AFTER first dose. Hold for glucose < 120 mg/dL.
[2] Hold for glucose < 100 mg/dL or if NPO

Continued on next page

APPENDIX D: Basal/Bolus Insulin Dosing Calculation Tables - continued

Note: • Clinical judgement may supersede exact calculation of total daily dose if patient's clinical status has rapidly changed during transition period
• Consider dose reduction in patients with renal dysfunction

Continuous Enteral Feedings

Average Hourly Dose of Insulin Infusion	First Dose of Basal Insulin (Glargine)	Maintenance Dose of Basal Insulin (Glargine)[1]	Dose of Scheduled Regular Insulin[2]	Regular Insulin Supplemental Sliding Scale
Less than or equal to 1 unit/hour	9 units once	5 units every 12 hours	3 units every 6 hours	Low dose sliding scale every 6 hours
2 units/hour	19 units once	10 units every 12 hours	4 units every 6 hours	Low dose sliding scale every 6 hours
3 units/hour	28 units once	14 units every 12 hours	7 units every 6 hours	Medium dose sliding scale every 6 hours
4 units/hour	38 units once	19 units every 12 hours	9 units every 6 hours	Medium dose sliding scale every 6 hours
5 units/hour	48 units once	24 units every 12 hours	12 units every 6 hours	High dose sliding scale every 6 hours

[1] Maintenance dose of basal insulin (glargine) should start no sooner than 12 hours AFTER first dose. Hold for glucose < 120 mg/dL.
[2] Hold for glucose < 100 mg/dL or if enteral feedings interrupted and notify ICU Team

SUGGESTED READINGS

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