VANDERBILT UNIVERSITY MEDICAL CENTER

Guideline: Burn Unit Glycemic Control Guidelines

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I. Background:

Hyperglycemia is commonly seen in patients with burn injuries as part of the burn inflammatory stress response. The presence of diabetes and hyperglycemia has been known to be a risk factor for infectious complications in surgical patients. Insulin therapy has been demonstrated to improve outcomes in critically ill trauma patients.[1-3]

In 2001, Van den Berghe evaluated 1,548 consecutive mechanically ventilated surgical ICU patients.[4] Patients were randomized to either control (180-200 mg/dL) or treatment (80-110 mg/dL) managed by an insulin infusion. The treatment arm or "tight" glucose control resulted in a significant reduction in mortality, particularly in the population with prolonged ICU stays (> 5 days). Tight glucose control resulted in a 32% adjusted risk reduction for mortality, fewer overall infections, less renal replacement therapy and decreased incidence of critical illness polyneuropathy.

In 2009, the NICE-SUGAR study randomized 6,104 adults expected to receive ICU care for at least 3 days to receive intensive glucose control (goal 81-108 mg/dL) or conventional glucose control (goal ≤ 180mg/dL).[5] 90-day mortality was 27.5% in the intensive-control group vs. 24.9% in the conventional group (adjust odds ratio 1.14; 95% CI 1.01-1.20). The median survival time was lower in the intensive-control group compared to the conventional-control group (HR 1.11; 95%CI, 1.01-1.23). Severe hypoglycemia was also reduced in the conventional group (0.5% vs. 6.8% in the intensive-control group, $p < 0.001$). This landmark trial led to the establishment of BG targets of <180 mg/dL or most critically ill patients and avoidance of overly stringent BG targets which may lead to higher rates of hypoglycemia.

The Society of Critical Care Medicine (SCCM) 2024 glycemic control guidelines suggest initiation of glycemic management protocols and procedures to treat persistent hyperglycemia (≥180 mg/dL) in critically ill adults.[6] Continuous IV insulin infusions are suggested to be utilized over intermittent subcutaneous insulins for acute hyperglycemia management, though with a conditional recommendation with a very low certainty of evidence. Insulin therapies should be titrated to achieve BG ≤ 180 mg/dL without causing hypoglycemia (defined as BG < 80 mg/dL). If continuous insulin infusions are utilized, frequent (≤1 hour, continuous, or near continuous) blood glucose monitoring should be implemented. Glycemic control protocols and procedures should have a low risk of hypoglycemia and hypoglycemia should be treated promptly with oral carbohydrates or administration of IV dextrose (50%), depending on severity, while avoiding increases in glucose variability.[6-7] High glucose variability has been associated with increased infections, prolonged ventilator, and ICU length of stay, and increased mortality.[8]

Additionally, a study at Vanderbilt found that the provision of balanced nutrition rather than simply carbohydrate reduces hypoglycemia rates.[9]

II. Burn Pathophysiology and Implication on Hyperglycemia

The hypermetabolic state induced from injury predisposes the burn patient to infectious complications and impairs wound healing through glycation and immunoglobins and suppression of acute phase reactants. It decreases tensile wound strength and reduces success of graft take.[10] This natural response from the body also stimulates gluconeogenesis, glycogenolysis and insulin resistance. Admission hyperglycemia has been shown to be a risk factor for poor outcomes in trauma, and a recent study shows that the same holds true for burns. This independently predicts the development of bacteremia, UTI, and pneumonia. However, a diagnosis of diabetes was not found to be a predictor of infection or mortality.[11]

It is therefore imperative, due to the morbidity associated with hyperglycemia in burn patients, that each admission to the BICU be closely monitored for this treatable dyscrasia. In 2015 Stoecklin et all published in *Burns* a 15-year cohort study showing how a standardized ICU glucose control protocol can aid in improving these outcomes.[12] This was performed specifically in burn patients, and they concluded that moderate glycemic control by protocol was safe in this population and that a nurse-driven protocol resulted decreased rates of hypoglycemia as opposed to a physician- guided protocol.

III. BICU Guidelines for Maintenance of Euglycemia:

All patients in the Burn ICU (BICU) will have blood glucose (BG) levels and a HbA1c checked upon admission. Each patient in the unit will be considered as high risk or low risk depending on clinical status. The high-risk group will receive more frequent blood glucose monitoring. Patients may change between risk categories as their clinical course unfolds.

Category 1- High Risk	Category 2- Conservative Management
• Sepsis • Acute resuscitation (need for ongoing resuscitation within 24 h) • Inotropic/Vasopressor support • Acute organ dysfunction • Acute respiratory failure (exception- extubation planned within 12-24 hrs after admission)	• Hemodynamically stable • Not mechanically ventilated

<u>High Risk Patients – Category 1</u>

- Begin blood glucose monitoring every 4 hours via point-of-care device.
- Initiate Burn/Trauma sliding scale insulin order panel for any blood glucose value > 150 mg/dL
- If blood glucose values remain elevated (≥ 180 mg/dL), adjust sliding scale insulin to provide more units of insulin per BG range

- Consider discontinuing q4h blood glucose monitoring and sliding scale insulin if: (must meet all of these)
    - Blood glucose remains < 150 mg/dL for 48 hours.
    - Consistent oral intake or tube feeds/parenteral nutrition (PN) at goal for 24 hours.
    - Patient is off vasopressors.

Considerations for Continuous Insulin Infusion

- If two successive blood glucose values are ≥ 200 mg/dL, a continuous insulin infusion should be considered using the ICU insulin infusion protocol.
- Patients should have a glucose source - D10 at 30 mL/hr, unless:
    - D5LR or D5NS are ordered at > 50mL/hr
      AND
    - Tube feeds at 50% of goal or on PN
- Select goal target range of 100-130 mg/dL

This is a nurse-driven protocol in Epic. When a nurse obtains a BG value, they will enter it into the insulin infusion advisor. This will calculate a new infusion rate and/or amount of D50W to be given. For reference, below is the titration calculation in Epic.

Insulin infusion titration calculation:

Drip Rate (units/hr) = [Blood Glucose (BG) – 60] x multiplier

The insulin infusion algorithm considers the patient's dextrose source, site of BG test, the current BG value, the previous BG value, and the previous multiplier. The algorithm is as follows:

- After two successive BG readings > 130 mg/dL, the multiplier increases.
- If BG < 100 mg/dL, the multiplier decreases.
- If BG within target range, no change to multiplier.
- If BG less than 60 mg/dL, multiplier is set to zero.
- If BG greater than 1.5 x (130) AND previous multiplier is zero, set multiplier to 0.01.
- If BG ≥ previous BG AND previous BG > 1.25 x (130) AND previous multiplier is zero, set multiplier to 0.01.

Hypoglycemia treatment:

D50W Dose Calculation:

D50W dose = (85 – BG) x 0.5 (rounded to nearest 5 mL)administered via IV push

Blood Glucose Reading	Recommended D50W by IV push
71-80	5mL
61-70	10mL
51-60	15mL
41-50	20mL
31-40	25mL
26-30	30mL
<25	35mL

Consider transitioning continuous insulin infusion to sliding scale insulin if:

- Critical illness resolved, subcutaneous absorption appropriate, and without new clinical deterioration.
- Insulin infusion requirements of ≤ 3 units/hr for 24 hours AND receiving a stable source of nutrition.

Consider addition of basal insulin- give ~50% of insulin total daily dose (TDD) received from continuous insulin infusion over the past 24 hours. Schedule the basal insulin as q AM or q HS depending on when order is being placed.

Low Risk Patients – Category 2

- Begin blood glucose monitoring every 6 hours via point-of-care device.
- Initiate sliding scale subcutaneous insulin if blood glucose value is **between 111-250 mg/dL**
- If blood glucose values remain elevated (> 150 mg/dL), consider adjusting sliding scale insulin to provide more units of insulin per BG range to help achieve target blood glucose of 110-160 mg/dL
- If two successive blood glucose values are ≥ 250 mg/dL, a continuous insulin infusion should be considered using the above insulin infusion protocol in Category 1 above (requires transition to BICU level of care)
- Consider discontinuing 6h blood glucose monitoring and sliding scale insulin if: (must meet all of these)
  - Blood glucose remains < 150 mg/dL for 48 hours
  - Consistent oral diet intake or tube feeds/PN at goal for 24 hours.

IV. Burn Stepdown Guidelines for Maintenance of Euglycemia:

1. On admission, the following patients should have an HbA1c and scheduled POC glucose monitoring ordered:
    - Patients with known diabetes, regardless of admission BG
    - Patients without known diabetes if BG ≥140 (at any point during admission)
    - Patients > 50 years of age
2. Based on admission/inpatient blood glucose levels and the patient's history of diabetes, they will be classified and treated according to the following groups:
    - Group 1: Patients without diabetes
    - Group 2: T2D and euglycemic (BG≤150)
    - Group 3: T2D and hyperglycemic (BG>150)
3. Initial Treatment
    - Group 1 (patients without diabetes)
        i. Insulin
            1. Order Burn/Trauma sliding scale insulin panel **if single BG > 150 at any time during admission.**
            2. Consider discontinuing sliding scale insulin if BG < 150 for 48 hours AND receiving goal nutrition.
        ii. Monitoring
            1. POC BG monitoring TID AC plus qHS (if taking PO) or q6h (if NPO, on tube feeds, or PN)
            2. If A1c > 6.5%, then switch patient to group 2 or 3 based on BG levels.
    - Group 2 (T2D with euglycemia on admission)
        i. Insulin
            1. Order sliding scale insulin regardless of admission BG
            2. Insulin Dependent T2D: Resume insulin glargine at 50% of home dose in addition to Burn/Trauma sliding scale insulin panel.
            3. Non-Insulin Dependent T2D: Start insulin glargine 0.1 units/kg/day in addition to Burn/Trauma sliding scale insulin panel
            4. If BG remains >180 mg/dL, consider scheduled prandial insulin with meals if on a diabetic diet OR scheduled short-acting insulin q4-6h if on continuous tube feeds or PN.
            5. *Use of only a sliding scale insulin regimen in the inpatient hospital setting in patients with diabetes is strongly discouraged.*
        ii. Monitoring
            1. POC BG monitoring TID AC plus qHS (if taking PO) or q6h (if NPO or on tube feeds/PN
    - Group 3 (T2D with hyperglycemia on admission)
        i. Insulin
            1. Order Burn/Trauma sliding scale insulin regardless of admission BG
            2. Insulin Dependent T2D: Resume insulin glargine at 75% of home dose (if

receiving long-acting insulin in the outpatient setting) in addition to Burn/Trauma sliding scale insulin panel.

3. Non-Insulin Dependent T2D: Start basal-bolus regimen at insulin total daily dose (TDD) of 0.3 units/kg/day, with half the TDD given as insulin glargine once a day and the other half of TDD prandial insulin administered prior to meals (if eating) or q4-6h (if on continuous tube feeds), in addition to Burn/Trauma sliding scale insulin panel.
    a. Reduce initial insulin TDD to 0.15 units/kg/day for the following patients:
        i. ≥ 70 years old
        ii. SCr ≥ 2 mg/dL (or ≥50% baseline SCr)

ii. Monitoring

1. POC BG monitoring TID AC plus qHS (if taking PO) or q6h (if NPO or on tube feeds/PN)

Consult Endocrine consult if:

- Unable to adequately control blood glucose AND:
    - Known diabetes with HbA1C >7%, OR
    - Insulin infusion rate remains >4 units/hr despite adding long-acting insulin.
- Patient uses an insulin pump
- Patient has history of Type 1 diabetes
- Assistance with insulin infusion tapering is needed
- Patient uses U-500 insulin at home
- Patient has history of pancreatic insufficiency
- Patient has newly diagnosed diabetes

V. Treatment of hypoglycemia (BG≤ 70 mg/dL)

<u>Treatment of Hypoglycemia (BG)—Always notify house officer</u>

- If patient is on basal and/or sliding scale insulin:
    - Juice 4 oz (120 mL) by mouth every 15 minutes as needed
    - Glucose chewable tablet 16 grams by mouth every 15 minutes as needed (if unable to tolerate oral juice)
    - Dextrose 50% 25 mL intravenous every 15 minutes as needed (if unable to take oral juice or glucose)
    - Glucagon 1 mg intramuscular as needed (if unable to take oral juice or glucose and unable to place or use IV); give one dose
- If patient is on continuous insulin infusion:
    - Dextrose 50% 5-40 mL intravenous as needed (dose based on protocol calculation)

VI. Notify Providers if:

- Any blood glucose value below 60 mg/dL
    - Two successive blood glucose values less than 80 mg/dL
    - Two successive blood glucose values greater than 250 mg/dL
    - A recommended insulin infusion rate greater than 22 units/hr

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