

VANDERBILT  UNIVERSITY  
MEDICAL CENTER

**Guideline:** Burn Unit Glycemic Control Guidelines

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**Content Experts**

Anne Wagner, MD  
Robel Beyene, MD  
Sarah Cogle, PharmD

**Table of Contents**

I.	Background: .....	2
II.	Burn Pathophysiology and Implication on Hyperglycemia.....	3
III.	BICU Guidelines for Maintenance of Euglycemia:.....	3
IV.	Burn Stepdown Guidelines for Maintenance of Euglycemia:: .....	6
V.	Treatment of hypoglycemia (BG $\leq$ 70 mg/dL) .....	8
VI.	Notify Providers if: .....	8
VII.	References:.....	9

**I. Background:**

Hyperglycemia is commonly seen in the burn intensive care unit (BICU) 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<sup>1-3</sup>.

In 2001, Van den Berghe evaluated 1,548 consecutive mechanically ventilated surgical ICU patients<sup>4</sup>. 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, demonstrated fewer overall infections, required less dialysis, and experienced less critical illness polyneuropathy.

In 2009, the NICE-SUGAR study randomized 6,104 adult patients 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  $\leq$  180mg/dL)<sup>5</sup>. At 90 days after randomization, 27.5% in the intensive-control group died, as compared with 24.9% in the conventional-control group. The adjusted odds ratio for 90-day mortality was 1.14 (95% CI, 1.01-1.29,  $p = 0.04$ ). 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,  $p=0.03$ ).

There was also a significantly reduced rate of severe hypoglycemia in the conventional-control group versus the intensive-control group (0.5% vs. 6.8%,  $p < 0.001$ ).

As a result, the Society of Critical Care Medicine (SCCM) published guidelines on the use of insulin infusions for the management of hyperglycemia in critically ill patients<sup>6</sup>. The authors suggest using an insulin protocol to target a blood glucose goal range of 100-150 mg/dL, while maintaining blood glucose values less than 180 mg/dL. These guidelines also focus on the importance of avoiding hypoglycemia, defined as a blood glucose  $< 70$  mg/dL<sup>7,8</sup>. To avoid adverse effects of hypoglycemia, the guidelines recommend frequent blood glucose monitoring and the restoration of normoglycemia through the administration of dextrose (50%) while avoiding increases in glucose variability. High glucose variability has been associated with increased infections, prolonged ventilator, and ICU length of stay, and increased mortality<sup>9</sup>.

Additionally, studies at Vanderbilt have also shown that provision of balanced nutrition rather than simply carbohydrate reduces hypoglycemia rates<sup>10</sup>.

**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<sup>14</sup>. 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<sup>15</sup>.

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 al published in *Burns* a 15-year cohort study showing how a standardized ICU glucose control protocol can aid in improving these outcomes<sup>16</sup>. 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 physician guided.

**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
<ul style="list-style-type: none"> <li>• Sepsis</li> <li>• Acute resuscitation (need for ongoing resuscitation within 24 h)</li> <li>• Inotropic/Vasopressor support</li> <li>• Acute organ dysfunction</li> <li>• Acute respiratory failure (exception- extubation planned within 12-24 hrs after admission)</li> </ul>	<ul style="list-style-type: none"> <li>• Hemodynamically stable</li> <li>• Not mechanically ventilated</li> </ul>

### **High Risk Patients – Category 1**

- 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, consider adjusting sliding scale insulin to provide more units of insulin per BG range help achieve target blood glucose of <180 mg/dL.
- 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  $\geq 200$  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, he/she 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:**

$$\text{Drip Rate (units/hr)} = [\text{Blood Glucose (BG)} - 60] \times \text{multiplier}$$

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  $1.5 \times (130)$  AND previous multiplier is zero, set multiplier to 0.01.
- If BG  $\geq$  previous BG AND previous BG >  $1.25 \times (130)$  AND previous multiplier is zero, set multiplier to 0.01.

**Hypoglycemia treatment:**

**D50W Dose Calculation:** D50W dose =  $(85 - BG) \times 0.5$  (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

**Notify House Officers Parameters include:**

- Any BG reading below 60 mg/dL
- Two successive BG readings less than 80 mg/dL
- Two successive BG readings greater than 200 mg/dL
- A recommended insulin infusion rate greater than 22 units/h

**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  $\leq 3$  units/hr for 24 hours AND are on 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  $\geq 250$  mg/dL, a continuous insulin infusion should be considered using the above insulin infusion protocol in Category 1 above (requires 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/parenteral nutrition (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  $BG \geq 140$  at any point during admission
  - Patients  $> 50$  years of age
2. Based on admission/inpatient blood glucose levels and patient's history of diabetes, they will be classified and treated according to the following groups:
  - Group 1: Patients without diabetes
  - Group 2: T2DM and euglycemic ( $BG \leq 150$ )
  - Group 3: T2DM 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 (T2DM with euglycemia on admission)
    - i. Insulin
      1. Order sliding scale insulin regardless of admission BG
      2. IDDM: Resume insulin glargine at 50% of home dose in addition to Burn/Trauma sliding scale insulin panel.
      3. NIDDM: 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 (T2DM with hyperglycemia on admission)

i. Insulin

1. Order Burn/Trauma sliding scale insulin regardless of admission BG
2. IDDM: Resume insulin glargine at 75% of home dose in addition to sliding scale insulin.
3. NIDDM: 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.  $\geq 70$  years old
    - ii.  $SCr \geq 2$  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.
  - Insulin infusion tapering if needed.
  - Patient uses U-500 insulin at home.
  - Patient has history of pancreatic insufficiency.
  - Patient has newly diagnosed diabetes.

**V. Treatment of hypoglycemia (BG  $\leq$  70 mg/dL)**

Treatment of Hypoglycemia (BG)—Always notify house officer

- 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 1mg 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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