

**VANDERBILT UNIVERSITY MEDICAL CENTER
MULTIDISCIPLINARY SURGICAL CRITICAL CARE**

SURGICAL INTENSIVE CARE UNIT GLYCEMIC CONTROL PROTOCOL

Background:

For some time, the presence of diabetes and hyperglycemia has been known to be a risk factor for infectious complications in surgical patients. Latham R, et al. evaluated 1000 consecutive cardiac surgery patients (including non-diabetic) for incidence of infectious complications. Overall, 3% developed surgical site infections and patients with at least one perioperative glucose value ≥ 200 mg/dL had adjusted odds of infections twice as high as non-hyperglycemic patients.¹ This study did not evaluate treatment or control of hyperglycemia and its effect on infectious outcomes. Richards et al. and Kauffmann et al. found similar results in non-diabetic orthopedic trauma patients.^{2,3}

A landmark study was published by Van den Berghe, et al. in 2001 and set a new standard of care for glucose control in critically ill and injured surgical patients.⁴ The authors performed a randomized trial of 1548 consecutive mechanically-ventilated SICU patients. Patients were randomized to either control (180-200 mg/dL) or treatment (80-110 mg/dL) managed by insulin infusion. On day one of admission, all patients received IV glucose and were subsequently changed to some form of nutritional support by day 2, either TPN or TEN. Patients with glucose values above the randomization range received continuous infusion IV insulin titrated at one hour intervals to reach their target levels. Once glucose control had stabilized, glucose analysis intervals were lengthened to every two or four hours. "Tight" glucose control resulted in a significant reduction in mortality for the group overall, but particularly the population with prolonged ICU stays (>5days). Tight glucose control resulted in a 32% adjusted risk reduction for mortality. For the total population, inclusion in the treatment arm resulted in fewer deaths due to sepsis but not deaths due to other causes. This group also demonstrated fewer overall infections, less requirement for dialysis, and less critical illness polyneuropathy.

In 2009, the NICE-SUGAR study was published and challenged the findings of the Van den Berghe et al trial. The NICE-SUGAR study randomized 6104 adult patients who were 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 ≤ 180 mg/dL).⁵ At 90 days after randomization, 27.5% in the intensive-control group had 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, $p = 0.04$). Also, 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, $p=0.03$). Another relevant finding was the significantly reduced rate of severe hypoglycemia in the conventional-control group versus the intensive-control group (0.5% vs. 6.8%, $p < 0.001$). Patients admitted for operative reasons benefitted from conventional control, although this was called into controversy in a meta-analysis including NICE-SUGAR trial results.⁶ Due to the inability to achieve consensus, some practitioners began to question intensive insulin therapy.

In December 2012, the Society of Critical Care Medicine (SCCM) published guidelines on the use of insulin infusions for the management of hyperglycemia in critically ill patients.⁷ 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 BG < 70 mg/dL, agreeing with earlier work from our institution that the length of time on insulin therapy is related to hypoglycemia, although severe hypoglycemia is not necessarily related to mortality.^{8,9} To avoid the adverse effects of hypoglycemia, the guidelines recommend frequent blood glucose monitoring (every 1-2 hours) and the restoration of normoglycemia through the administration of dextrose (50%) while avoiding increases in glucose variability. Studies at Vanderbilt have also shown that provision of balanced nutrition rather than simply carbohydrate reduces hypoglycemia rates.¹⁰ Subcutaneous insulin may be used in a select group of ICU patients with low insulin requirements and who are clinically stable and off vasopressors.

Guidelines for Maintenance of Euglycemia:

All patients admitted to the Surgical ICU (SICU) should have a blood glucose level checked upon admission via a point-of-care device. High risk patients (Category 1) will require initiation of the insulin infusion protocol, and Low risk (Category 2) patients will be started on sliding scale insulin. Please see categories below.

Category 1 – High Risk:

Sepsis
Acute resuscitation
Inotropic/Vasopressor support
Acute organ dysfunction
Acute respiratory failure

Category 2 – Low Risk:

Hemodynamically stable
Not mechanically ventilated

High Risk Patients – Category 1

1. **Begin continuous insulin infusion using SICU insulin drip protocol**
2. **Select SICU goal target range of 100-130 mg/dL**

This is a nurse-driven protocol in Wiz (HEO). 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 Wiz (HEO).

Insulin infusion titration calculation:

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

The insulin infusion algorithm takes into account the patient's dextrose source, site of BG test, the current BG value, the previous BG value, and the previous multiplier.

- 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.

D50W Dose Calculation: D50W dose = (85 – BG) x 0.5 (rounded to nearest 5 mL)

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

3. 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/hr

4. Consider changing to the SICU subcutaneous insulin regimen if:

- Critical illness resolved, subcutaneous absorption appropriate, and without new clinical deterioration
- Minimal insulin requirements for 24 hours

5. Consider Endocrine consult if a patient meets the following criteria:

- Patient's BG values are not being adequately controlled
- AND**
- Patient is a known diabetic on an insulin regimen at home
 - Continuous insulin infusion rate remains ≥ 5 units/hr despite addition of long-acting insulin glargine

Low Risk Patients – Category 2

1. Blood glucose 111 - 250 mg/dL, begin Subcutaneous Insulin Therapy

- Q 4 hr accu-checks and dosing
- Subcutaneous insulin dose (units of regular insulin) calculated as:
$$\frac{\{[\text{blood glucose (mg/dL)}] - 90\}}{15}$$
- Adjust insulin dose using denominator (number divided by) as needed to reach target of 110 – 150 mg/dL
- Notify ICU resident if questions

2. Blood glucose > 250 mg/dL, begin SICU insulin infusion protocol

- Initiate and titrate as per guideline of Category 1 above

3. Consider initiating home anti-hyperglycemic regimen if adequate oral intake and mobility is present. Contact MD for orders.

References

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