



# YALE INSULIN INFUSION PROTOCOL



Adapted from Goldberg PA, et al.<sup>29</sup> (*Endocrine Practice*. July/August 2006.)

The following insulin infusion protocol is intended for use in hyperglycemic adult patients in an ICU setting, but is not specifically tailored for those individuals with diabetic emergencies, such as diabetic ketoacidosis (DKA) or hyperglycemic hyperosmolar syndrome (HHS). When these diagnoses are being considered, or if BG  $\geq$  500 mg/dL, an MD should be consulted for specific orders. Also, notify the responsible physician immediately if the response to the insulin infusion is unusual or unexpected, or if any situation arises that is not adequately addressed by these guidelines. Any patient on an insulin infusion should have frequent measurement of serum electrolyte concentrations, especially potassium.

## Initiating the Insulin Infusion

- 1.) INSULIN INFUSION: Mix 1 unit Regular Human Insulin per 1 mL 0.9% NaCl. Administer via infusion pump (in increments of 0.5 unit/hr.)
- 2.) PRIMING: Flush 20 mL of infusion through all IV tubing before infusion begins (to saturate insulin binding sites in tubing.)
- 3.) THRESHOLD: IV insulin is indicated in any critically ill patient with persistent BG  $\geq$  140 mg/dL; consider use if BG > 120 mg/dL.
- 4.) TARGET BLOOD GLUCOSE (BG) LEVEL: 90-120 mg/dL
- 5.) BOLUS & INITIAL INSULIN INFUSION RATE: If initial BG  $\geq$  150, divide initial BG level ( mg/dL) by 70, then round to nearest 0.5 unit for bolus AND initial infusion rate. If initial BG < 150 mg/dL, divide by 70 for initial infusion rate only ( i.e., NO bolus.)

Examples: 1) Initial BG = 335 mg/dL:  $335 \div 70 = 4.78$ , rounded up to 5: Give 5 units IV bolus + start infusion @ 5 units/hr.

2) Initial BG = 148 mg/dL:  $148 \div 70 = 2.11$ , rounded down to 2: Start infusion @ 2 units/hr ( NO bolus.)

## Blood Glucose (BG) Monitoring

- 1.) Check BG hourly until stable (defined as 3 consecutive values in target range.) In hypotensive patients, capillary blood glucose ( i.e., "fingersticks") may be inaccurate and obtaining a blood sample from an indwelling vascular catheter is preferable.
- 2.) Then check BG Q 2 hours; once stable x 12-24 hours, BG checks can be spaced to Q 3-4 hours IF:
  - a) no significant change in clinical condition AND
  - b) no significant change in nutritional intake.
- 3.) If any of the following occur, consider the temporary resumption of hourly BG monitoring, until BG is again stable:
  - a) any change in insulin infusion rate (i.e. BG out of range)
  - b) significant changes in clinical condition
  - c) initiation or cessation of steroid or pressor therapy
  - d) initiation or cessation of dialysis or CVVH
  - e) initiation, cessation, or rate change of nutritional support (TPN, PPN, tube feedings, etc.)

## Changing the Insulin Infusion Rate

If BG < 50 mg/dL:

**HOLD INSULIN INFUSION. Give 1 Amp (25 g) D50 IV;** recheck BG Q 10-15 minutes

⇒ When BG  $\geq$  90 mg/dL, wait 1 hour, recheck BG. If still  $\geq$  90 mg/dL, restart infusion at 50% of most recent rate.

If BG 50-69 mg/dL:

**HOLD INSULIN INFUSION. If symptomatic (or unable to assess), give 1 amp (25 g) D50 IV; recheck BG Q 15 minutes.**

If asymptomatic, consider 1/2 Amp (12.5 g) D50 IV or 8 ounces juice PO; recheck BG Q 15-30 minutes.

⇒ When BG  $\geq$  90 mg/dL, wait 1 hour, recheck BG. If still  $\geq$  90 mg/dL, restart infusion at 75% of most recent rate.

## Changing the Insulin Infusion Rate (cont'd.)

If BG  $\geq$  70 mg/dL:

**STEP 1:** Determine the CURRENT BG LEVEL - identifies a COLUMN in the table:

| BG 70-89 mg/dL | BG 90-119 mg/dL | BG 120-179 mg/dL | BG $\geq$ 180 mg/dL |
|----------------|-----------------|------------------|---------------------|
|----------------|-----------------|------------------|---------------------|

**STEP 2:** Determine the RATE OF CHANGE from the prior BG level - identifies a CELL in the table - Then move right for **INSTRUCTIONS**:

[Note: If the last BG was measured 2-4 hrs before the current BG, calculate the hourly rate of change. Example: If the BG at 2PM was 150 mg/dL and the BG at 4 PM is now 120 mg/dL, the total change over 2 hours is -30 mg/dL; however, the hourly change is  $-30 \text{ mg/dL} \div 2 \text{ hours} = -15 \text{ mg/dL/hr}$ .]

| BG 70-89 mg/dL  | BG 90-119 mg/dL   | BG 120-179 mg/dL                                     | BG $\geq$ 180 mg/dL                                    | INSTRUCTIONS*   |
|---|---|--|--|---|
|   |   | BG $\uparrow$ by $> 40$ mg/dL/hr                     | BG $\uparrow$  | INCREASE INFUSION by "2 $\Delta$ "                    |
|   | BG $\uparrow$ by $> 20$ mg/dL/hr  | BG $\uparrow$ by 1-40 mg/dL/hr<br>OR<br>BG UNCHANGED | BG UNCHANGED<br>OR<br>BG $\downarrow$ by 1-40 mg/dL/hr | INCREASE INFUSION by " $\Delta$ "                     |
| BG $\uparrow$   | BG $\uparrow$ by 1-20 mg/dL/hr,<br>BG UNCHANGED, OR<br>BG $\downarrow$ by 1-20 mg/dL/hr | BG $\downarrow$ by 1-40 mg/dL/hr                     | BG $\downarrow$ by 41-80 mg/dL/hr                      | NO INFUSION CHANGE                                    |
| BG UNCHANGED<br>OR<br>BG $\downarrow$ by 1-20 mg/dL/hr              | BG $\downarrow$ by 21-40 mg/dL/hr   | BG $\downarrow$ by 41-80 mg/dL/hr                    | BG $\downarrow$ by 81-120 mg/dL/hr                     | DECREASE INFUSION by " $\Delta$ "                     |
| BG $\downarrow$ by $> 20$ mg/dL/hr<br><i>see below</i> <sup>†</sup> | BG $\downarrow$ by $> 40$ mg/dL/hr  | BG $\downarrow$ by $> 80$ mg/dL/hr                   | BG $\downarrow$ by $> 120$ mg/dL/hr                    | HOLD INFUSION X 30 min then DECREASE by "2 $\Delta$ " |

<sup>†</sup> HOLD INSULIN INFUSION; check BG Q 15-30 min; when  $\geq 90$  mg/dl, restart infusion at 75% of most recent rate.

\* **CHANGES IN INFUSION RATE** ("delta" or " $\Delta$ ") are determined by current infusion rate:

| Current Infusion Rate (units/hr) | $\Delta$ = Rate Change (units/hr) | 2 $\Delta$ = 2X Rate Change (units/hr) |
|----------------------------------|-----------------------------------|--|
| < 3                              | 0.5                               | 1                                      |
| 3 - 6                            | 1                                 | 2                                      |
| 6.5 - 9.5                        | 1.5                               | 3                                      |
| 10 - 14.5                        | 2                                 | 4                                      |
| 15 - 19.5                        | 3*                                | 6*                                     |
| 20 - 24.5*                       | 4*                                | 8*                                     |
| $\geq 25^*$                      | 5*                                | 10*                                    |

Note: To convert values for glucose from mg/dL to mmol/L, multiply by 0.05551.

\* Depending on the clinical circumstances, infusion rates typically range between 2-10 units/hr. Doses in excess of 20 units/hr are unusual, and, if required, the responsible MD should be notified to explore other potential contributing factors (including technical problems, such as dilution errors, etc.)